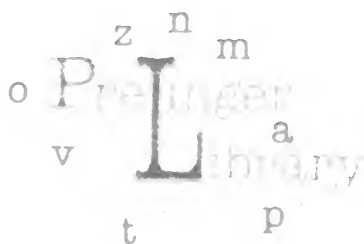




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ANNUAL REPORTS
OF THE
DEPARTMENT OF
AGRICULTURE

FOR THE YEAR ENDED JUNE 30,

1919.

REPORT OF THE
SECRETARY OF AGRICULTURE.

REPORTS OF CHIEFS.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.

1920.

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1918/19

[CHAPTER 23, Stat. L., 1895.]

[AN ACT Providing for the public printing and binding and the distribution of public documents.]

* * * * *

Section 73, paragraph 2:

The Annual Report of the Secretary of Agriculture shall hereafter be submitted and printed in two parts, as follows: Part One, which shall contain purely business and executive matter which it is necessary for the Secretary to submit to the President and Congress; Part Two, which shall contain such reports from the different Bureaus and Divisions, and such papers prepared by their special agents, accompanied by suitable illustrations, as shall, in the opinion of the Secretary, be specially suited to interest and instruct the farmers of the country, and to include a general report of the operations of the Department for their information. There shall be printed of Part One, one thousand copies for the Senate, two thousand copies for the House, and three thousand copies for the Department of Agriculture; and of Part Two, one hundred and ten thousand copies for the use of the Senate, three hundred and sixty thousand copies for the use of the House of Representatives, and thirty thousand copies for the use of the Department of Agriculture, the illustrations for the same to be executed under the supervision of the Public Printer, in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture; and the title of each of the said parts shall be such as to show that such part is complete in itself.

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REPORT OF THE SECRETARY OF AGRICULTURE.

REPORT OF THE SECRETARY OF AGRICULTURE.

WASHINGTON, D. C., *November 15, 1919.*

SIR: America during the war helped to save Europe and to preserve civilization by making available to the Allies, through increased production and conservation, large supplies of foodstuffs. But for this contribution, it is difficult to see how the Allies could have waged the war to a victorious conclusion. Lacking such support and with their own producing capacity seriously crippled, the German people experienced partial famine conditions; their health and vitality were greatly impaired; and the collapse of their military power was due in no small measure to the shortage of food.

The cessation of hostilities brought no immediate improvement in Europe. On the contrary, in some respects more adverse conditions developed. Revolution became the order of the day; the directing hand of government was removed; discipline was relaxed; the morale, particularly of the people of the Central Powers, was broken; idleness and unemployment prevailed; and in some sections anarchy reigned. It was obvious that Europe could not produce sufficient foods for herself. Her crops had been short for several years and it was scarcely probable that those for 1919 would be greater than the crops of the last year of the war. Quite as unsatisfactory was the live-stock situation. In nine of the western nations the number of cattle had declined more than 7,000,000, sheep 7,500,000, swine 24,500,000, and dairy cows several millions, with a greater proportionate reduction in the volume of products.

Food relief after the armistice was imperative not only for the peoples of the new small friendly nations but also of the enemy countries. It became the key to the whole situation and to the establishment of a real peace. Europe had to be fed if order was

to be restored and if European civilization, and, therefore, that of all the world, including our own, was to be preserved. America had again to assist in saving Europe and herself by supplying food, and that in great abundance. It was estimated that Europe would need to import at least 20,000,000 tons of bread grains alone, and that of this quantity 11,000,000 must come from the United States. It was obvious also that she would call for large imports of meats and fats, and that for months, until shipping expanded again, most of these must be obtained from the United States. This burden America was able to assume because of the achievements of her farmers. The full story can not be told; only the outcome can be suggested.

1919 ACREAGES AND YIELDS.

The farmers of the Nation, in 1919, planted an acreage in leading cereals greater by 33,000,000 than the prewar annual average (1910-1914), which, it is estimated, will yield 635,000,000 bushels more than the prewar average, and increased the number of milch cows over 1914 by 2,700,000, of other cattle by 8,500,000, of swine by 16,700,000, and of horses and mules by 1,000,000, or a total of 28,900,000. The planting operations for the year began before the fighting ceased. The call was still for more wheat: The Department suggested a maximum fall acreage of 47,206,000 acres, an increase of 12 per cent over 1918. There was actually planted 49,261,000, the largest acreage in the Nation's history, 6,960,000 acres more than in 1918 and 15,608,000 more than the five-year average, 1910-1914. The spring-wheat acreage was 22,593,000, while the winter and spring plantings combined amounted to 71,854,000 acres, or 7,200,000 more than the preceding record and 19,400,000 more than the prewar average. It is estimated that the yield will exceed that of 1918 by 1,000,000 bushels and will be the Nation's second record wheat crop. The estimated corn crop of 2,910,000,000 bushels will be 300,000,000 greater than that of 1918 and only slightly less than the high yields of 1915 and 1917.

If the fighting had continued and the season had been favorable, there is little question that the farmers of the country would have planted an aggregate crop acreage, during the winter and spring, greater than that for any preceding year in the Nation's history.

Forecasts of meat production for 1919, from partial reports of slaughtering, indicate that the record figure of last year—20,250,000,000 pounds—will be exceeded. The total will probably reach 21,000,000,000 pounds, as follows: Pork, 12,900,000,000 pounds, compared with 11,248,000,000 in 1918 and 8,769,000,000 in 1914; beef, 7,500,000,000 as against 8,500,000,000 in 1918 and 6,079,000,000 in 1914; and mutton, 600,000,000 pounds as against 537,000,000 in 1918 and 739,000,000 in 1914.

A rough estimate, based upon the number of milch cows and the census average of milk production per cow, indicates that the number of gallons of milk produced in 1919 will aggregate 8,495,000,000, or 57,000,000 more than in 1918 and 1,029,000,000 more than the average for 1910-1914. The figures for poultry and egg production have not been accurately ascertained, but it is roughly estimated, upon the basis of reported increases from one census to another, that egg production in 1919 will aggregate 1,957,000,000 dozen, as against 1,921,000,000 in 1918 and 1,774,000,000 in 1914, and that the number of poultry raised on farms will approximate 600,000,000.

EXPORTS.

The exports of foodstuffs, enormous during the war, rose greatly between the armistice and midsummer. The annual average exports of important cereals for the five years preceding the war were 162,000,000 bushels. They rose to 517,000,000 in 1915 and aggregated 448,000,000 in 1919. Dairy products, of which 25,000,000 pounds were exported on the average during the five-year period before the war, increased in volume to 102,400,000 pounds in 1915, 217,500,000 in 1916, 352,000,000 in 1917, 592,000,000 in 1918, and 781,000,000 in 1919; while the exports of meat and meat products were 1,291,000,000 pounds for the five-year average before the war, 1,500,000,000 in 1915, 1,800,000,000 in 1916, 2,300,000,000 in 1918, and 3,300,000,000 in 1919.

The following tables may facilitate the examination of these essential facts:

Acreage of crops in the United States.

[Figures refer to planted acreage for winter wheat and rye.]

Crops.	1919 (unrevised estimate, October, 1919).	1918 (subject to revision). ¹	1917	1916	1915	1914	Annual average, 1910-1914.
CEREALS.							
Corn.....	102,977,000	107,494,000	116,730,000	105,296,000	106,197,000	103,435,000	105,240,000
Wheat.....	71,854,000	64,707,000	58,366,000	56,810,000	61,173,000	54,661,000	52,152,000
Oats.....	42,169,000	44,400,000	43,553,000	41,527,000	40,996,000	38,442,000	38,014,000
Barley.....	8,899,000	9,679,000	8,933,000	7,757,000	7,148,000	7,565,000	7,593,000
Rye.....	6,820,000	6,708,000	4,480,000	3,474,000	3,153,000	2,733,000	2,562,000
Buckwheat.....	943,000	1,040,000	924,000	828,000	769,000	792,000	826,000
Rice.....	1,091,300	1,112,770	980,900	869,000	802,600	694,000	733,000
Kafirs.....	5,183,000	5,619,000	5,153,000	3,944,000	4,153,000	.....	.....
Total.....	239,936,300	240,759,770	239,119,900	220,505,000	224,391,600	2208,322,000	2207,420,000
VEGETABLES.							
Potatoes.....	4,003,000	4,210,000	4,384,000	3,565,000	3,734,000	3,711,000	3,686,000
Sweet potatoes...	1,023,000	922,000	919,000	774,000	731,000	603,000	611,000
Total.....	5,026,000	5,132,000	5,303,000	4,339,000	4,465,000	4,314,000	4,297,000
Tobacco.....	1,774,300	1,549,000	1,518,000	1,413,000	1,369,900	1,224,000	1,209,000
Cotton.....	32,390,000	35,890,000	33,841,000	34,985,000	31,412,000	36,832,000	35,330,000
Grand total ..	279,126,600	283,330,770	279,781,900	261,242,000	261,638,500	2250,692,000	2248,256,000

¹ Figures for 1918 are to be revised Dec. 12, 1919.

² Excluding grain sorghums.

Production in the United States.

[The figures are in round thousands, i. e., 000 omitted.]

Crop.	1919 (unre- vised estimate, November, 1919).	1918 (subject to revision).	1917	1916	1915	1914	Annual average, 1910-1914.
CEREALS.							
Corn..... bushels..	2,910,250	2,582,814	3,065,233	2,566,927	2,994,793	2,672,804	2,732,457
Wheat..... do.....	918,471	917,100	636,655	636,318	1,025,801	891,017	728,225
Oats..... do.....	1,219,521	1,538,359	1,592,740	1,251,837	1,549,030	1,141,060	1,157,961
Barley..... do.....	198,298	256,375	211,759	182,309	228,851	194,963	186,208
Rye..... do.....	84,552	90,183	62,933	48,862	54,050	42,779	37,568
Buckwheat..... do.....	20,120	17,182	16,022	11,662	15,056	16,881	17,022
Rice..... do.....	44,261	40,424	34,739	40,861	28,947	23,649	24,378
Kafrs..... do.....	123,343	66,396	61,409	53,858	114,460	.....	.....
Total..... do.....	5,518,816	5,508,833	5,681,490	4,792,634	6,010,988	4,983,143	4,883,819
VEGETABLES.							
Potatoes..... bushels..	352,025	400,106	442,108	286,953	359,721	409,921	360,772
Sweet potatoes..... do.....	102,946	86,334	83,822	70,955	75,639	56,574	57,117
Beans (commercial)..... do.....	12,690	17,437	16,045	10,715	10,321	11,585	.....
Onions, commercial crop..... do.....	10,784	13,396	12,376	8,562	7,664	(²)	.....
Cabbage (commercial)..... tons..	388	516	475	255	671	(²)	.....
FRUITS.							
Peaches..... bushels..	51,327	34,133	45,066	37,505	64,097	54,109	43,752
Pears..... do.....	13,628	10,342	13,281	11,874	11,216	12,086	11,184
Apples..... do.....	144,429	169,911	163,117	204,582	76,670	263,200	197,898
Cranberries (3 States)..... barrels..	546	343	249	471	441	644	.....
MISCELLANEOUS.							
Flaxseed..... bushels..	9,450	14,657	9,164	14,296	14,030	12,749	18,353
Sugar beets..... tons..	7,296	5,890	5,980	6,228	6,511	5,585	5,391
Tobacco..... pounds..	1,316,553	1,340,019	1,249,276	1,153,278	1,062,237	1,034,679	991,958
All hay..... tons..	103,544	90,443	98,439	110,992	107,263	88,686	81,640
Cotton..... bales..	10,696	12,041	11,302	11,450	11,192	16,135	14,259
Sorghum sirup..... gallons..	33,668	29,224	37,472	13,668	.....	.....	.....
Peanuts..... bushels..	44,966	54,434	52,505	35,324	.....	.....	.....
Broom corn (5 States)..... tons..	51	58	57	39	.....	.....	.....
Clover seed..... bushels..	967	1,102	1,488	1,706	.....	.....	.....

¹ Excludes grain sorghums.² No estimate.*Number of live stock on farms on January 1, 1910-1919.*

[The figures are in round thousands, i. e., 000 omitted.]

Kind.	1919	1918	1917	1916	1915	1914	Annual average, 1910-1914.
Horses.....	21,534	21,555	21,210	21,159	21,195	20,962	20,430
Mules.....	4,925	4,873	4,723	4,593	4,479	4,449	4,346
Milch cows.....	23,467	23,310	22,894	22,108	21,262	20,737	20,676
Other cattle.....	44,399	44,112	41,689	39,812	37,067	35,855	38,000
Sheep.....	49,863	48,603	47,616	48,625	49,956	49,719	51,929
Swine.....	75,587	70,978	67,503	67,766	64,618	58,933	61,865

Estimated production of meat, milk, and wool.

[The figures are in round thousands, i. e., 000 omitted.]

Product.	1919	1918	1917	1916	1914	1909
Beef ¹.....pounds..	7,500,000	8,465,000	7,384,007	6,670,938	6,078,908	8,138,000
Pork ¹.....do....	12,868,000	11,248,000	8,450,148	10,587,765	8,768,532	8,199,000
Mutton and goat ¹.....do....	637,000	537,000	491,205	633,969	739,401	615,000
Total.....do....	21,005,000	20,250,000	16,325,360	17,892,672	15,586,841	16,952,000
Milk ².....gallons..	8,495,000	8,438,000	8,288,000	8,003,000	7,507,000	7,466,406
Wool (including pulled wool), pounds.....	308,459	298,870	281,892	288,490	290,192	289,420
Eggs produced ³.....dozen..	1,957,000	1,921,000	1,884,000	1,848,000	1,774,000	⁴ 1,591,000
Poultry raised ³.....number..	600,000	589,000	578,000	567,000	544,000	⁴ 488,000

¹ Estimated for 1914-1918 by the Bureau of Animal Industry. Figures for meat production for 1919 are tentative estimates based upon 1918 production and a comparison of slaughter under Federal inspection for 6 months of 1919 with the corresponding 6 months in 1918.

² Estimated for 1914-1919 by assuming 362 gallons as the average yearly production of milk per cow. This average is given in the census for 1909.

³ Estimated by assuming a constant increase since 1910.

⁴ Annual averages for 1910-1914: Eggs, 1,695,000,000 dozen; poultry, 522,000,000.

Exports of domestic foodstuffs and cotton from the United States.

Reports of Bureau of Foreign and Domestic Commerce, United States Department of Commerce.)

Article exported.	Annual average, 1910-1914.	Year ending June 30—					1919		Three months, July to September, 1919.
		1915	1916	1917	1918	Amount.	Per cent of 1910-1914.		
Wheat.....bushels.....	56,913,228	259,642,533	173,274,015	149,831,427	34,118,853	178,582,673	313.8	35,651,158	
Wheat flour.....barrels.....	10,678,635	16,182,765	15,520,669	11,942,778	21,880,151	24,190,062	226.5	5,132,968	
Oats.....bushels.....	8,304,203	96,809,551	95,918,884	88,944,401	105,881,233	96,360,974	1,160.4	14,273,916	
Rye.....do.....	854,765	12,544,888	14,532,437	13,260,015	12,005,922	27,540,188	3,222.3	3,691,246	
Barley.....do.....	7,855,521	26,754,522	27,473,160	16,381,077	26,408,978	20,457,751	259.1	16,643,135	
Corn.....do.....	39,809,690	48,786,291	38,217,012	64,720,842	40,997,827	16,687,538	41.9	2,613,519	
Total 5 cereals, including flour.....do.....	161,831,264	517,360,227	419,258,518	336,880,263	317,933,402	448,484,568	.....	95,971,330
Sugar.....pounds.....	70,976,908	549,007,411	1,630,150,863	1,248,908,286	576,415,850	1,115,865,524	1,572.2	333,452,731	
Dairy products:									
Butter.....do.....	4,277,955	9,850,704	13,487,451	26,835,092	17,735,966	33,739,960	788.7	4,416,051	
Cheese.....do.....	4,915,502	55,362,917	44,394,301	66,050,013	44,330,978	18,794,833	382.4	2,465,335	
Milk, condensed.....do.....	15,773,900	37,235,627	159,577,620	259,141,231	529,750,032	728,740,509	4,619.9	192,881,959	
Total dairy products.....do.....	24,967,357	102,449,248	217,459,402	352,026,336	591,816,976	781,275,322	.....	199,763,345
Meat and meat products:									
Canned beef.....pounds.....	9,392,122	75,243,261	50,803,765	67,536,125	97,366,983	108,489,472	1,155.1	9,500,174	
Fresh beef.....do.....	29,452,302	170,440,934	231,214,000	197,177,101	370,057,514	332,205,176	1,127.9	24,041,841	
Pickled beef.....do.....	32,893,172	31,874,743	38,114,682	58,053,667	54,867,310	45,067,801	137.0	9,338,564	
Oleo oil.....do.....	280,224,505	80,481,946	102,645,914	67,110,111	56,648,102	59,092,322	21.1	18,626,949	
Bacon.....do.....	182,474,062	346,718,227	579,808,786	667,151,972	815,319,424	1,239,540,973	679.3	259,009,482	
Hams and shoulders.....do.....	166,813,134	203,701,114	282,208,611	266,656,581	419,571,869	667,848,019	400.4	105,869,800	
Pickled pork.....do.....	48,274,929	45,655,574	63,460,713	46,982,721	33,221,502	31,504,497	65.3	7,362,746	
Lard.....do.....	474,354,914	475,531,908	427,011,338	444,769,540	392,498,435	725,577,868	153.0	154,092,726	
Lard compounds.....do.....	67,318,857	69,980,614	52,843,311	56,359,493	31,278,382	131,750,503	195.7	19,030,447	
Total meat and meat products.....do.....	1,291,198,027	1,499,028,321	1,828,111,120	1,871,807,311	2,270,829,521	3,341,076,691	.....	606,812,729
Cotton.....do.....	4,419,802,137	4,403,575,499	3,084,070,125	3,068,080,786	2,320,511,665	2,733,683,125	61.9	632,449,973	

Exports of live stock from the United States.

[Bureau of Foreign and Domestic Commerce, United States Department of Commerce.]

Kind.	Annual average, 1910-1914.	Fiscal year ending June 30—					Three months, July to September, 1919.
		1915	1916	1917	1918	1919	
	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>
Horses.....	28, 073	289, 340	357, 553	278, 674	84, 765	22, 776	5, 971
Mules.....	5, 125	65, 788	111, 915	136, 689	28, 879	4, 883	906
Cattle.....	88, 225	5, 484	21, 287	13, 387	18, 213	18, 376	20, 803
Sheep.....	522, 505	182, 278	231, 535	58, 811	7, 959	152, 000	14, 186
Swine.....	11, 191	7, 799	22, 048	21, 926	9, 280	10, 122	2, 285

VALUES.

On the basis of prices that have recently prevailed, the total value of all crops produced in 1919 is \$15,873,000,000, compared with \$14,222,000,000 for 1918; \$13,479,000,000 for 1917; \$9,054,000,000 for 1916; \$6,112,000,000 for 1914; and \$5,827,000,000 for the five-year average, 1910-1914. These values represent gross production and not net returns to the producer. The value of live stock on farms in 1919 was \$8,830,000,000, compared with \$8,284,000,000 in 1918; \$6,736,000,000 in 1917; \$6,021,000,000 in 1916; \$5,890,000,000 in 1914; and \$5,318,000,000 for the five-year average, 1910-1914.

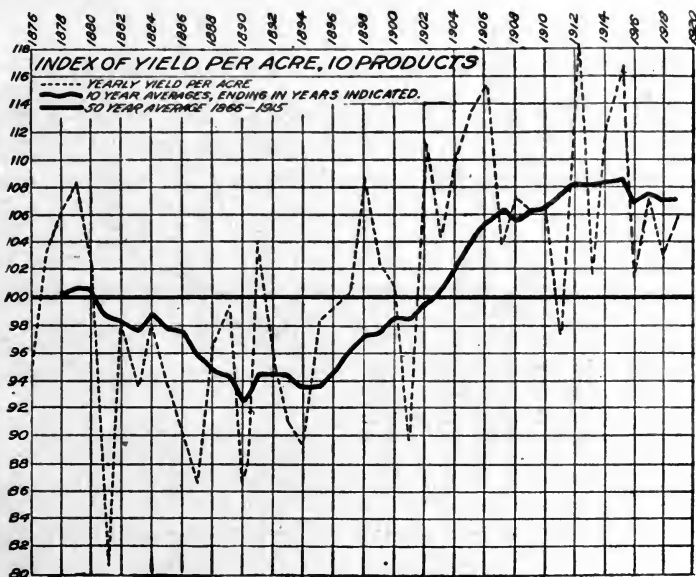
This increased financial showing, it is again necessary to emphasize, does not mean that the Nation is better off to that extent or that its real wealth has advanced in that proportion. Considering merely the domestic relations, the true state is indicated rather in terms of real commodities, comparative statements of which are given in the foregoing tables. The increased values, however, do reveal that the monetary returns to the farmers have increased proportionately with those of other groups of producers in the Nation and that their purchasing power has kept pace in the rising scale of prices.

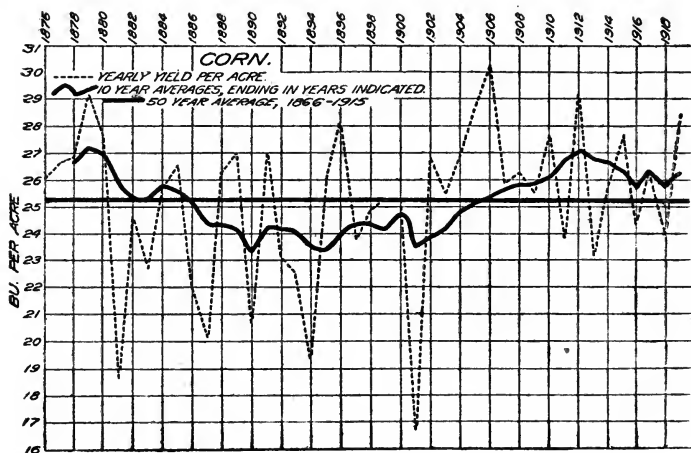
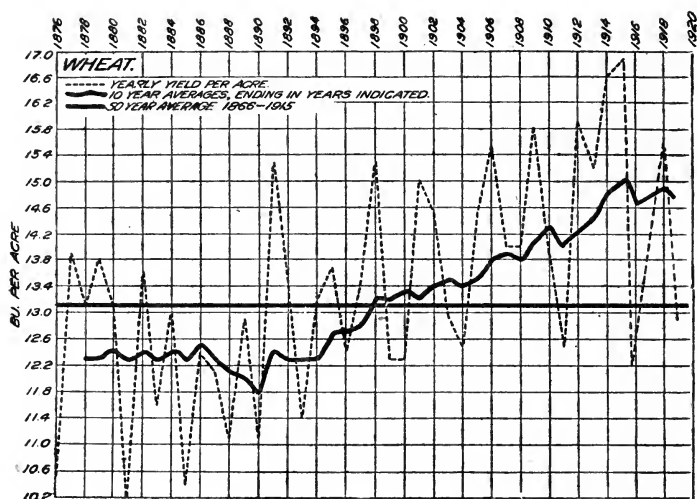
PROGRESS OF AMERICAN AGRICULTURE.

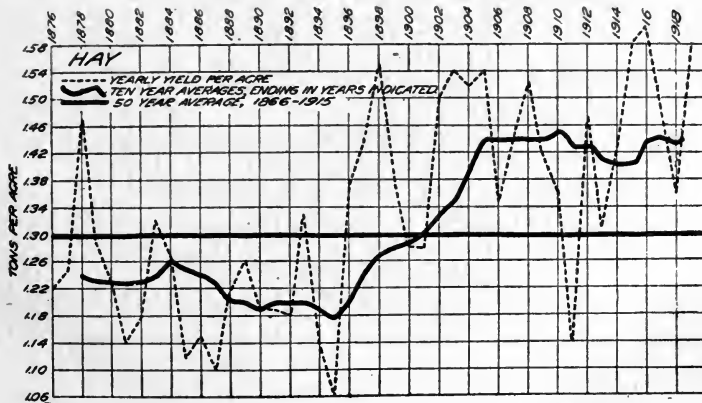
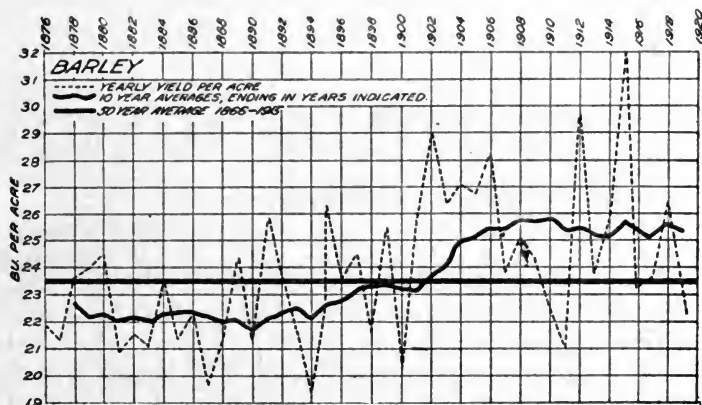
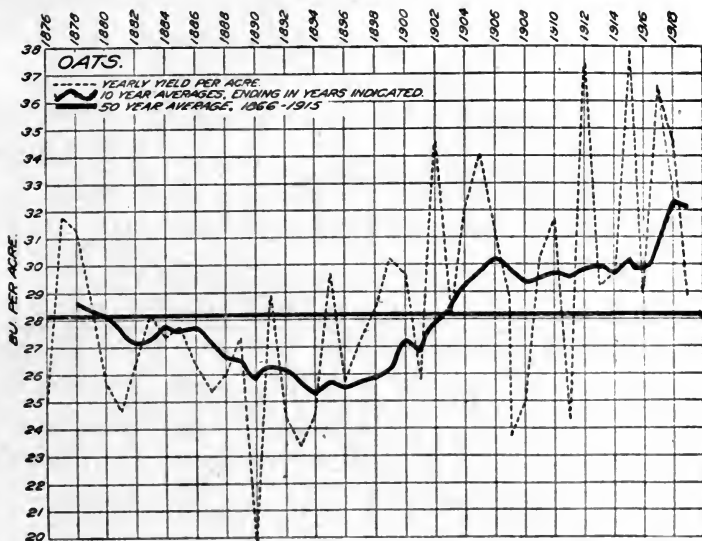
The results of agricultural operations during the war furnish guaranty of the ability of the present farm population of the country, with the area now in farms and in the existing state of agricultural science and practice, to meet the Nation's necessities for the near future if the requisite incentives are furnished. But there are reasons for further optimism. As has been repeatedly pointed out,

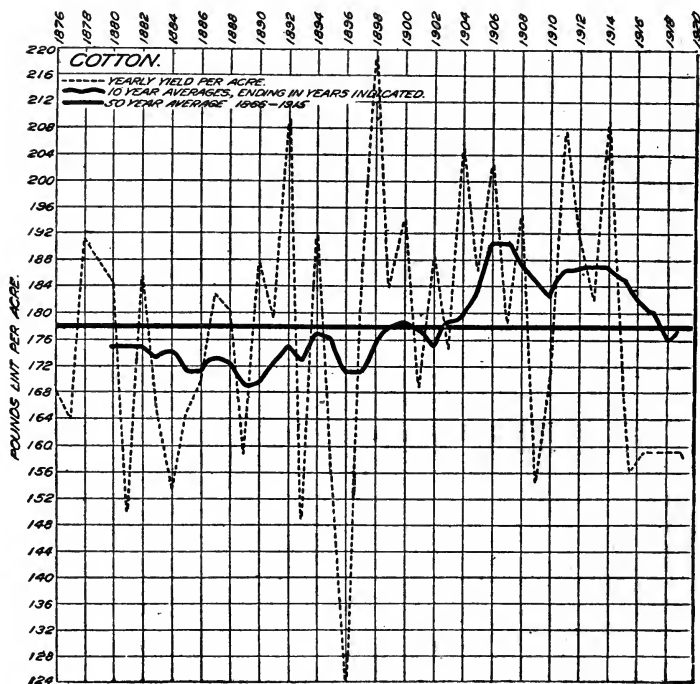
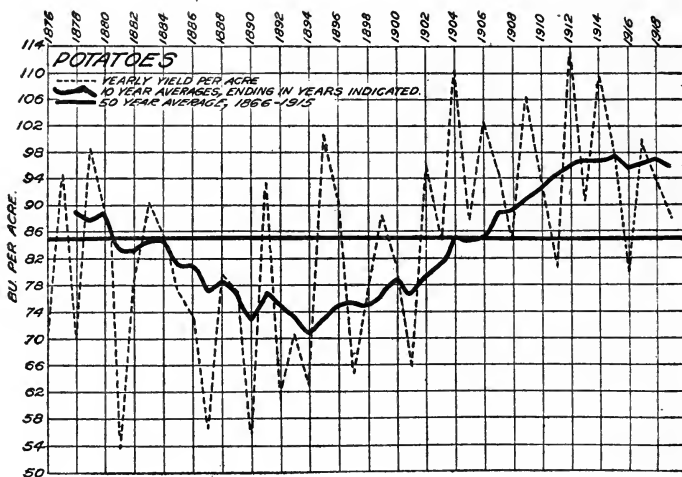
we still have a large area of untouched tillable land. This is somewhat generally understood, but it is not so well known that, as the result of improved processes and better practices in all sections, there has been an upward tendency in the acre yields. As a matter of fact, the view seems more frequently to be expressed that in this respect American agriculture has deteriorated. The facts disprove this, and in no part of the Union more strikingly than in the older regions, such as the New England and North Atlantic States.

Crop yields per acre in the United States show an upward tendency during the period for which we have reliable comparable statistics. The average rate of increase for the past 25 years has been about one-half of one per cent a year. This gain is not readily observed from one year to another, owing to the wide yearly fluctuations in yield. But when averages for a series of years are obtained, the effect of the seasonal variations is largely neutralized and the general trend is clear. The upward tendency is shown graphically in the following charts:









During the decades of the seventies and eighties, when there was a vast expansion of farm area in the West and crops were grown on a more and more extensive scale, the tendency of crop yields per acre was downward. Since the early nineties, however, the movement has been upward.

In the decade of the eighties, that is, for the 10 years ending with 1890, the average yield per acre of wheat in the United States was 11.84 bushels; for the past 10 years, that is, for the 10 years ending in 1918, it was 14.87—an increase of 25 per cent.

For the 10 years ending in 1890 the average yield of corn in the United States was 23.43 bushels; in the 10 years ending in 1918 it was 25.81—an increase of 10 per cent.

The oats yield in the 10 years ending in 1890 averaged 25.92 bushels, but in the 10 years ending in 1918 it was 32.17—a gain of 24 per cent.

The potato crop averaged 72.97 bushels per acre for the 10 years ending in 1890, and 96.84 for the last 10 years—an increase of nearly one-third.

By a like comparison, it may be observed that the hay yield rose from 1.193 tons per acre to 1.432—an increase of 20 per cent.

Cotton, notwithstanding the ravages of the boll weevil, increased from an average of 169.78 pounds in the decade ending in 1890 to 175.73 in the last decade—a gain of $3\frac{1}{2}$ per cent.

Other field crops have likewise shown greater yields. The average increase per acre of all crops in the 10 years ending in 1918, compared with the 10 years ending in 1890, was about 16 per cent.

The tendency toward enlarged output per acre is general throughout the United States; it is not due to a shifting of production from one section to another. For example, in the old agricultural State of New York the increases for the two periods mentioned above were as follows: Corn 24 per cent, wheat 44, oats 21, barley 24, buckwheat 43, potatoes 30, hay 10, average of all (weighted) 18 per cent. The facts for the New England States may appeal to many as even more striking and significant. For the six New England States, the following gains are shown in the 10-year period, 1909–1918, over the average for 1866–1875: Corn 33 per cent, wheat 63, oats 25, barley 27, rye 27, buckwheat 17, potatoes 27, hay 24,

and all field crops 25 per cent; and for the 10 years, 1909-1918, over the average for 1881-1890: Corn 38 per cent, wheat 60, oats 24, barley 29, rye 44, buckwheat 45, potatoes 69, hay 23, and all field crops 26 per cent. For convenience of comparison, the accompanying table is inserted:

Comparison of crop yields in six New England States.

Crops.	Percentage increase in average yields per acre during 10 years, 1909-1918, over—	
	10-year average, 1860-1875.	10-year average, 1881-1890.
Corn.....	33	38
Wheat.....	63	60
Oats.....	25	24
Barley.....	27	29
Rye.....	27	44
Buckwheat.....	17	45
Potatoes.....	27	69
Hay.....	24	23
All field crops (weighted).	25	26

The gains noted are real; that is, they are not due to changes in statistical method. They are observed in the official statistics of most foreign countries, as well as in those of the United States.

The increased production per acre shown is due, in considerable measure, to the practice of better agricultural methods, including the use of more efficient farm machinery; better knowledge and fuller adoption of crop rotations; planting of crops better adapted to prevailing climatic conditions; development and adoption of varieties more resistant to plant diseases and insect pests; more general application of disease and insect control measures; increased and more intelligent use of fertilizers; and improved efficiency in crop production generally.

FOREIGN YIELDS ALSO INCREASED.

Not only in the United States, but in most civilized countries of the world, the yield per acre has been tending upward in recent years. This is noted in respect to wheat in practically all wheat-growing countries. If we compare the average wheat yields per

acre in the 10-year period, 1891-1900, with those in 1901-1910, we find that in the United Kingdom there has been an improvement of 6 per cent, that is, from 30.1 to 31.9 bushels; in the Netherlands, of 19 per cent, or from 27.7 to 33; in New Zealand, of 28 per cent, or from 24.6 to 31.5; in Sweden, of 14 per cent, or from 24.2 to 27.6; in Germany, of 23 per cent, or from 23.6 to 29.1; in Ontario, of 12 per cent, or from 19.4 to 21.8; in Manitoba, of 7 per cent, or from 17 to 18.2; in France of 8 per cent, or from 18.1 to 19.5; in Hungary, of 3 per cent, or from 17.3 to 17.8; in Japan, of over 2 per cent, or from 17 to 17.4; in Poland, of 3 per cent, or from 15.5 to 15.9; in Roumania, of 21 per cent, or from 14 to 16.9; in the United States, of 8 per cent, or from 12.9 to 13.9; in India, of 16 per cent, or from 9.7 to 11.3; in Caucasia, of 18 per cent, or from 9.5 to 11.2; in Russia, excluding Poland and Caucasia, of 14 per cent, or from 8.3 to 9.5 bushels. These countries are given in the order of their relative rank in yield per acre during the period 1891-1900. Satisfactory comparative data are not available for Argentina. Similar gains have been observed in other crops.

The average yields in the United States are frequently compared with the much larger yields in some European nations. In Belgium the average yield is about double that in the United States; in the United Kingdom, more than 60 per cent greater, and in France, nearly 15 per cent. It should be borne in mind, however, that the energy of each American farmer is spread over a larger area and that, although he produces less per acre, he produces much more per man. The total output of the average farmer is probably greater in the United States than in any other country in the world. Thus, in Belgium, with its intensive system of farming, only about 5.3 acres are cultivated for each person engaged in agriculture, whereas, in the United States, the corresponding figure is 27 acres. Taking both acreage and yield per acre into consideration, the average American farmer produces 2.5 times as much as the average Belgian farmer; 2.3 times as much as the English; 3.2 times as much as the French; 2.5 times as much as the German; and over 6 times as much as the Italian.

For many years to come the average yield per acre in the United States may be expected to increase, although the total output per man may diminish. This country has a long distance to go before it comes in sight of its limit of farm production. It can further increase its output of commodities by continuing to secure increased

yields per acre. It has been estimated by experts that only about 15 per cent of the land in cultivation is yielding reasonably full returns. The opportunity is presented, as conditions warrant, to bring the remaining 85 per cent up to the point of fair yield. One of the objectives of all good farmers and of the agricultural agencies assisting them is to promote increased yields along economic lines by the further application of scientific knowledge and the adoption of improved practices. The path of progress is pretty well charted and the agricultural forces are moving along it with gratifying speed. However, the maintenance of satisfactory increases necessitates the continuance and enlargement of investigational work, particularly such as is required to insure fuller control of destructive plant diseases and insect pests.

FARM LAND PROBLEMS.

The Nation can further expand its output of commodities by cultivating the tillable land which at present is unused, estimated to be over 60 per cent of the total. But there has been no such full consideration of the policy which should be pursued in reference to the extension of the farm area as has been given to economical production. Since the Nation now retains but little land of ready availability, agricultural expansion will result mainly from efforts to utilize and to increase the productivity of farm lands now owned by individuals, corporations, and the States.

A number of important questions must be answered: How rapidly should new areas be developed? What means should be employed to bring new lands into use, so that settlers may achieve success, employ sound methods of husbandry, and establish a wholesome community life? What is the significance of the increase of tenancy and what may be done to establish a system of land tenure which will insure good farming and a sound and democratic foundation for American agriculture? What is the bearing of the increasing prices of land and the resulting speculation on the progress of agriculture and the welfare of the farmer?

EXPANSION OF AREA IN FARMS.

The expansion of the Nation's agriculture is limited by the supply of labor and capital available for farming purposes rather than by

the scarcity of undeveloped lands. It is true that, in general, the best land is already in cultivation, but without question much of the remainder can be tilled when the country reaches the economic stage which would justify its utilization.

There are numerous fallacious opinions with respect to the need of extending the farm area. Many people, noting the prevailing prices of agricultural products, demand increased production and insist that the remedy lies in immediate and rapid expansion of the acreage in farms. Others, observing large tracts of unused land, deplore the great waste of our resources. Still others explain the movement of population from rural districts to cities by the non-availability of land, which they attribute to land monopoly, speculation, and other evils. The demand for farm products, unlike the demand for manufactured articles, does not expand rapidly to meet a large increase in supply. There is a tendency toward an equilibrium between urban and agricultural industry. If too much labor and capital are diverted from farming, the relative prices, and consequently the relative profits, of agricultural activity will increase, and there will be a tendency toward expansion. If this is excessive, however, relative prices and profits will tend to decrease and the industry may suffer depression. The inelasticity of demand for farm products sets a very decided limit at a given time to the increase of population and capital profitably employed in agriculture.

It is not in the interest of producers or consumers to have large fluctuations in agricultural production. There is always danger of glutting the market and of serious loss. The aim rather should be to secure a steady flow of commodities of sufficient volume to supply an increasing demand at prices which will yield the farmer a decent wage and a fair profit on his investment. It seems difficult to get it into the minds of some people that farming is a business and must pay; that under modern conditions there can not be an unlimited number of farmers. There could be a larger proportion of farmers to total population if each farm were self-sufficient and produced no surplus of consequence, but to-day the average farmer produces many times what he consumes of some things and is dependent for his prosperity upon their profitable exchange for other articles which he uses. There should be, and in the long run there will tend to be, no more farmers in the Nation than are needed to produce the quantity

of products which can be disposed of at a profit. There will be farmers enough if the business of farming is made profitable and if rural life is made attractive and healthful. The consumers must be willing to pay prices for farm products which will enable farmers to produce them and to maintain a satisfactory standard of individual and community life. The Nation also must be prepared to omit nothing to improve the countryside. It is of the first importance that satisfactory schools, with courses of study related to the problems of rural life, be provided, that good roads be constructed, and that adequate provision be made to give rural communities the requisite sanitary and medical services, including hospital facilities. When these requirements are met, we shall not have to concern ourselves as to the number of farmers and the adequacy of our agricultural production. There will then be no difficulty in retaining in the rural districts a sufficient number of contented and efficient people. What we need is not a "back to the land" propaganda, but an acceleration of the movement for the improvement of the countryside which will render the abandonment of farms unnecessary and the expansion of farming inevitable.

There is reason to believe that a considerable expansion in farmland area occurred during the war. The acreage devoted to the 19 principal crops increased 10.1 per cent from 1914 to 1918. Accordingly, the crop area per capita increased from 3.22 acres in 1914 to 3.33 in 1918, or 3.4 per cent. This expansion probably resulted in part from the use for crops of land normally devoted to other purposes, especially to pasture. However, it seems to indicate that the farming industry has more than held its own during the period. This conclusion is confirmed by an increase not only in the per capita production of nearly all the important crops, but also, according to a recent report, in the number of cattle and swine per capita. Moreover, estimates for milk, eggs, and poultry indicate an increase in per capita production during the war. In view of these facts, it probably would be unwise to stimulate a large increase in the per capita farm acreage at the present time, especially where such an increase would have to be effected by utilizing land which is inferior or which would be made available at a heavy outlay for drainage, irrigation, or clearing. Apparently, therefore, American agriculture should consolidate the gains already made; prepare for the period of competition which is to be expected with the return of normal

world conditions, principally by increasing, through sound and economical methods, the productivity of areas already under cultivation; and utilize the services of the most experienced and judicious agricultural leaders in determining where, when, and how to bring into cultivation and develop public and private unused land.

The best experts of the Federal department and of the agricultural colleges should make a careful investigation of the possibilities of utilizing land not now devoted to agriculture. In respect to the 200,000,000 acres of cut-over land, the 60,000,000 requiring drainage, and the 30,000,000 which may be irrigated, there is great variation from district to district as to the possibility of economic use. Distinctive regions should be fully studied with a view to assemble all existing data on productivity, cost of making the land available, present tenure and prices, type of agriculture best adapted to the conditions, possible returns, minimum size of farms capable of supporting families in reasonable comfort, minimum equipment needed at the beginning of settlement, sources of credit, and marketing and transportation facilities.

LAND SETTLEMENT.

At present various private agencies are engaged in promoting land settlement. Many of them are honest in intention, promise, and practice; others keep within the letter of the law but, through exaggeration and indirection of statement, create false impressions in the mind of the settler. Many violate no canon of fair business practice, but their interest is in profits and they do not pursue a policy calculated to develop a profitable and wholesome community life. Only a few have made careful studies of the conditions of successful settlement and developed their business with a view to the settlers' progress and success. Practically all are seeking to realize the highest possible price for their undeveloped holdings, and the settler is compelled to face the problem of adjustment to pioneer conditions while carrying a burden of land value which often represents, in part, the capitalization of a future increase in earning power.

The intending settler of small means is rarely able to distinguish between the good and bad methods of selling land in new regions. The more unscrupulous the land company the more lurid are its

advertisements and the more extravagant its promises. Settlers often are induced to invest all their savings in land not suitable for successful farming, to purchase more land in relation to the capital available for development than they should, or to undertake projects the cost of clearing or reclamation of which will prove to be prohibitive. The results, in many instances, have been tragic failures after years of incredible hardships, waste of capital and of human lives, discouragement of intending settlers, and injury to the business of legitimate and well-meaning land concerns.

It would be desirable if governmental agencies, by systematic aid, should furnish reliable information to those seeking farms, should take particular pains, through their agricultural machinery, to give new settlers very special assistance and guidance, and, where conditions are favorable, should aid in the development of well-considered settlement plans.

TENANCY.

The increase of tenancy has become the subject of deep concern to thoughtful students of rural conditions. The tenant, on an average, remains on the same farm only about one-sixth as long as the owning farmer. Consequently, he often manifests little interest in the improvement of the farm and in the progress of the community. A certain proportion of tenants is normal and may not be unwholesome. Many farm owners, because of age or infirmity, find it necessary to retire. Their farms are temporarily operated by their sons or other relatives who subsequently may become owners through inheritance or purchase. Large numbers of young men with little capital find tenancy a convenient stage in their progress to ownership. Certain local studies reveal the fact that nearly two-thirds of the farm owners who operate their farms have passed through this stage. Frequently it serves as a useful period of apprenticeship in farm management before the heavier financial burdens of ownership are assumed.

In a great many cases the farmer has not yet acquired sufficient experience as a manager to operate his farm efficiently without the assistance of the landlord. In some instances, also, the tenant has been reared in an environment characterized by lack of thrift, self-restraint, and systematic industry. He may not have the general intelligence or technical knowledge to stand alone in the management of a farm. Where these personal limitations exist the solution

of the problem lies in education, training, and the development of systematic habits of industry and thrift rather than in radical changes in the system of tenure.

Since there will continue to be a certain number of tenants, every effort should be made to change the conditions of leasing so as to improve the methods of agriculture, increase the period of occupancy, and insure a fair division of returns; and the States should provide by law for a system of compensation by owners to tenants for unexhausted improvements and set up the necessary administrative machinery. Such arrangements have prevailed in England for many years to the benefit of all concerned.

Although landlords may, and often do, play an important part in financing and in operating farms, there are large numbers who live at a distance and who contribute nothing toward their efficient utilization or improvement. Moreover, they often fail to interest themselves in promoting the progress of the community in which their land is situated, although they benefit by such progress. Land, however, is peculiarly important to all the people and the welfare and prosperity of the community, as well as its economic and social progress, depend so vitally on its use and the relationship of the population to it that serious thought must be given to the problem of limiting absentee ownership.

The endeavor to develop a more harmonious and efficient relation between tenant and landlord and to restrict absentee landlordism does not obviate the necessity of taking measures to retard the increase of tenancy. The road to farm ownership should be made as smooth as possible. This may be accomplished in part by providing more liberal credit facilities. The Federal Farm-Loan System has furnished a means whereby farmers may conveniently borrow under the conservative conditions of first-mortgage security. However, an analysis of the amount loaned shows that only a small proportion of the net proceeds was ostensibly obtained for the purchase of farms.

In some sections the growth of tenancy has been stimulated by the fact that the price of land has been higher than the level justified by current earnings. Consequently, it has been more profitable to rent than to buy unless one wished to speculate in land values. Recently there has been a tendency for prices to increase with extreme rapid-

ity. There has been active, and in many respects unwholesome, speculation which has profited mainly the real estate agents. A heavy charge, therefore, has been placed against the earnings of the land on the assumption of the continuance of war prices. The advancing price of land is especially serious in the case of the undeveloped regions of the country. It constitutes an obstacle to development, for the actual settler is compelled to assume at the outset unduly heavy interest charges.

EXTENSION OF FORESTRY.

The continued dissipation of privately owned forests in every timber-producing region of the country is a matter of grave concern. The public does not fully realize its seriousness. If the area having little or no value for other than forest purposes is not protected, much of it will become practically nonproductive. Millions of acres in the older parts of the country where supplies of timber are needed by the communities have become almost valueless. Where the land is not valuable for agriculture large-scale lumbering operations are followed by local industrial depression, the timber industries migrate, population decreases, farmers lose their local market, taxable values decline, schools and roads deteriorate, and the economic and social life of the community suffer.

The problem presented is very difficult. Public forests are confined to relatively limited areas, except in the West. These will by no means supply the future needs of the country. At present the greater part of the lumber produced annually is cut from private lands on which the appearance of new growth is at best a matter of accident, is likely to be long delayed, or may never occur. Without concerted action under public cooperation and direction the problem will not be solved. Private initiative can not be depended upon to secure the requisite conservation.

The preservation of forests in all forest regions is of immediate concern and importance to farmers. Timber is an important farm crop. Farm woodlands comprise about 20 per cent of the farm area of the country. At the last census the value of the products from them was greater than that of the potato crop and nearly double that of the tobacco yield. Forestry, therefore, must be assigned a place in farm management. Farmers also are vitally concerned with national forestry problems. They consume more wood than any other

group and they are interested in seeing that there is available, at reasonable prices, a continuous supply of lumber and other forest products. A sound forestry policy does not conflict with agricultural settlement. In fact, it facilitates the cultivation of land suitable for agriculture, and also seeks to secure the proper handling of existing forests and the reforestation of denuded regions. On the other hand, forest devastation retards agricultural development.

NECESSARY STEPS.

Certain things seem clear. Fire is a great menace not only on forested but also on cut-over areas. Adequate protection, therefore, should be required of all owners. The public, through both the State and Federal Governments, should cooperate in organizing this service and should share the cost of maintaining it. It should also adopt such practical measures as may be necessary to bring about the discontinuance of all practices which result in turning the forests into wastes, and should aid private owners to perpetuate their forests by proper management. A well-balanced policy requires a much larger program of publicly-owned forests than at present. The acquisition of forest lands by the Federal Government is now proceeding under the Weeks forestry law. The total area approved for purchase to date is 1,835,298 acres. The continuation of the policy is sought by the National Forest Reservation Commission, and an estimate of an appropriation of \$10,000,000 will be placed before the Congress. And, furthermore, the consolidation of National Forest areas through exchange with private owners should be accelerated. There are now pending no less than 25 bills authorizing exchanges, and the enactment of a general law would be in the public interest. There is a growing demand for additions to the National Forests from the public lands in the States where such action is possible only through legislation. Recently a law authorizing the addition of 1,000,000 acres to the National Forests in central Idaho has been enacted.

Good forestry practice rests upon the possession of full and accurate data. Our present knowledge of the methods of securing the largest yields is inadequate. There is need of further information regarding the amount, quality, and distribution of existing timber supplies. A detailed inventory of our present resources and a survey of present and prospective needs are essential for constructive planning.

FARM MANAGEMENT AND FARM ECONOMICS.

Until comparatively recently studies in farm economics were neglected. In the last 10 or 15 years it has come to be recognized that the prosperity of the farmer depends as much upon good business methods as upon his practices in plant culture and animal husbandry. In 1906 the Department of Agriculture inaugurated investigations in farm management, which remained in the Bureau of Plant Industry until 1915, when the Office of Farm Management was established as a branch of the Office of the Secretary. During the latter part of the calendar year 1918 steps were taken to reorganize the work. At my request, a committee composed of recognized authorities on farm management and agricultural economics made a thorough study of the activities of the office, not only with a view to enlarge the scope and increase the efficiency of the work but also to outline definite methods of procedure to be followed in the study of farm-management problems, and especially the cost of producing agricultural products. The members of this committee were: G. F. Warren, professor of agricultural economics and farm management, State College of Agriculture, Ithaca, N. Y.; Andrew Boss, chief of the division of agronomy and farm management, State College of Agriculture, St. Paul, Minn.; H. C. Taylor, head of the department of agricultural economics, College of Agriculture of the University of Wisconsin, Madison, Wis.; J. A. Foord, professor of farm management, State College of Agriculture, Amherst, Mass.; J. I. Falconer, professor of rural economics, State College of Agriculture, Columbus, Ohio; R. L. Adams, professor of agronomy, State College of Agriculture, Berkeley, Calif.; and G. I. Christie, Assistant Secretary of Agriculture and Director of Extension in Indiana.

This committee submitted a report to me, which I approved and which has been published as Circular No. 132 of the Office of the Secretary. It not only outlined the field of work of the Office of Farm Management but also recommended that its name be changed to Bureau of Farm Management and Farm Economics, and that the investigations conducted by it be carried on in close cooperation with the agricultural colleges and experiment stations in order to prevent duplication of effort, to promote the development of farm management activities in the various States, and

to unify the methods and improve the general character of all farm management work. On the basis of these recommendations, separate conferences were held for the purpose of indicating in greater detail the activities proposed by the reorganization committee, and especially to consider the projects relating to cost of production, farm organization, land utilization, and farm life.

These conferences resulted in the following approved projects:

(1) **COST OF PRODUCTION STUDIES.**—The value and importance of such studies are set forth clearly in the report of the reorganization committee, as follows:

Cost of production studies are of value to the individual farmer and, at the same time, are helpful in ascertaining the economic status of farming as an industry.

From the standpoint of the individual farmer the primary purposes are:

(1) To record the details of the farm business for reference.

(2) To give an insight into the elements and interrelations of the different farm activities.

(3) To furnish information that may enable the farmer to reduce costs or otherwise increase profits.

(4) To make possible a comparison of the profitableness of the different enterprises and combinations of enterprises.

The records secured by cost of production studies give data for analyzing the farm business, and thus are of fundamental importance in the whole program of agricultural research and education. The results of such studies on a number of farms where a given type of farming is practiced are useful not only to the farmers from whose farms the results were obtained, but are of value in showing other farmers how to improve their methods.

From the standpoint of the public, cost of production studies provide the facts which give a basis for intelligent judgment upon the probable effects of any given legislation or other public activity upon the farmer as a producer and as a citizen. Cost of production studies are therefore one of the means of providing the basic facts needed by legislators and price commissions in comparing the profits of competing lines of production and estimating necessary price.

(2) **FARM-LIFE STUDIES.**—These studies are to be conducted with a view to make living conditions in the home and in the community more satisfactory to the farm family. They will cover the following topics: Rural home life; opportunities for social contacts in typical rural communities; the relation of educational and religious institutions to farm-life problems; problems relating to geographical population groups, such as the relation of urban and rural populations, the shifting of rural populations, race elements in rural

districts; social aspects of tenancy and landlordism; rural organizations, their efficiency, scope, causes of success and failure; social aspects of various types of farm labor—the married and unmarried farm hand, seasonal and child labor; the relation of various forms of disability—the aged, illiterate, defective, dependent, delinquent—to farm-life problems; and the social consequences of local disasters due to natural causes, as well as of thrift and agencies for promoting it.

(3) **LAND ECONOMICS (LAND UTILIZATION)**, involving the consideration of land resources, values, ownership and tenancy, settlement and colonization, and land policies.

(4) **FARM ORGANIZATION.**

(5) **FARM FINANCIAL RELATIONS.**

(6) **FARM LABOR STUDIES.**

(7) **AGRICULTURAL HISTORY AND GEOGRAPHY; and**

(8) **DEMONSTRATION ACTIVITIES.**

The supervision of the task of executing the new program was assigned to Dr. H. C. Taylor, who was appointed Chief of the Office of Farm Management. Dr. Taylor, before accepting this position, owned and operated a farm in Wisconsin and also was head of the department of agricultural economics in the college of agriculture, University of Wisconsin. The department also secured the services of Mr. Francis W. Peck, of the University of Minnesota, who has had wide experience in studies of the cost of producing farm products, to take charge of the enlarged activities in this important field; of Dr. L. C. Gray, of Peabody College, to direct the work relating to land economics; and of Prof. C. J. Galpin, of the college of agriculture of the University of Wisconsin, to supervise the farm-life studies. This is merely a part of the plan to secure some of the best available minds in the country to direct the work relating to farm management and farm economics.

APPROPRIATIONS REQUIRED.

Arrangements promptly were made to develop the activities of the Office of Farm Management along the lines suggested by the reorganization committee. As it was clear that existing funds were inadequate, I submitted to the Congress, on May 23, 1919, a revised estimate calling for appropriations, during the fiscal year 1920, aggregating

\$611,990, compared with \$305,090 during the fiscal year 1919, an increase of \$306,900. Aside from statutory salaries, it was proposed to allot the appropriation to the following lines of work, in the amounts indicated:

Cost of production studies.....	\$245, 000
Farm organization.....	53, 600
Farm finance and farm relations.....	21, 560
Agricultural history and geography.....	29, 200
Land economics (land utilization).....	112, 920
Farm-life studies.....	20, 560
Demonstration activities (extension work).....	32, 820

It was hoped that the necessary additional funds would be included in the agricultural appropriation bill for 1920, which was then pending. Unfortunately, however, Congress did not take favorable action on the proposal. It not only did not grant the increases recommended but inserted a proviso in the bill which restricts the amount that may be expended on cost of production studies during the present fiscal year to \$23,873.

Although the funds at the disposal of the office were small, every effort has been made to carry out the reorganization program along the lines indicated. I am renewing, in the estimates of the department for the fiscal year 1921, the recommendation that approximately \$611,900 be provided, and that the name of the present Office of Farm Management be changed to Bureau of Farm Management and Farm Economics.

Having secured the best experts available to direct the principal activities of the office, I am confident that the work now under way and proposed, if the necessary funds are appropriated, will be executed in a highly satisfactory way, and that facts and information of immense value to individual farmers in dealing with their own problems, and also to the Nation for its guidance in considering broad agricultural policies, will be obtained and made available.

CROP AND LIVE-STOCK REPORTING SERVICE.

Accurate and complete statistics are prerequisite to the satisfactory consideration of any problem. They are of overwhelming importance to the millions of people interested in rural life, and especially those charged with the responsibility of aiding, by legislative and administrative processes, the successful development of our great agricultural industry. Suggestions as to the direction of production

and plans to improve marketing and distribution wait upon them, and in any national crisis they are essential to the intelligent handling of the Nation's food problems. In this direction, as in many others, the war has brought home in very direct fashion the need of improvement.

The value of dependable information on acreage, crop yield, number of live stock, and farm surpluses can not be overestimated. The Bureau of Crop Estimates has slowly developed an organization to secure and verify many valuable data. It is now necessary to extend it. The time has arrived for placing the work in all the States on a county basis. It is important that the live-stock and feed-reporting service be enlarged, that farm surpluses be ascertained, and that information regarding foreign crop and live-stock production be more fully secured and reported. It is peculiarly urgent that this be done at the present time. The 1920 census is about to be taken. It will furnish new base lines, and the department should be in a position, by reason of an improved service, to supply the country each year after the census with as full and accurate data as possible.

Estimates to make it practicable for the department to execute the enlarged program will be laid before the Congress for consideration at its regular session. If they are approved, the field force of the bureau will be strengthened by placing an assistant field agent and a clerk in each State. Additional specialists also will be appointed to collect, interpret, and present information regarding special crops and classes of live stock. The bureau then will be in a position to report for the Nation as a whole, for each State, and for each county, monthly or oftener if necessary, acreages to be planted; surpluses or deficiencies of seed, fertilizer, labor, and farm machinery; acreages actually planted; progress of farm work; acreages abandoned and harvested; damage from weather conditions, insects, and plant diseases; condition of crops and forecasts of production; yields per acre and production at or near harvest; acreages and yields of principal varieties of each crop; disposition and utilization of the crops produced; marketable surpluses and stocks on farms; prices received by farmers as distinguished from market quotations; prices farmers pay for supplies, machinery, and equipment; hours and wages of farm labor; and the foreign situation. These reports will cover about 70 crops, including such special items as vegetables, nuts, fruits, seed, oils, forest products, and

nursery stock, for all which adequate reports have not been available, except in the census years.

Likewise, there will be given the number of horses, mules, dairy cattle, beef cattle, swine, sheep, goats, and poultry, by age and sex classifications corresponding with the census enumeration of January, 1920; of pure bred animals of each kind; of those bred, born, or brought on to the farm; of those sold, slaughtered, or lost through disease, exposure, or other causes; of those remaining on hand and on feed; the condition of the various classes of animals; farm prices; and the feed situation, including the carrying capacity of pastures and ranges, the number of silos, the quantity of silage and other forage available, as well as the domestic meat, dairy, poultry, wool, and hide production, and the foreign situation.

Available foreign crop and live stock estimates will be secured and published, especially for countries of deficient supply and those of surplus production in competition with the United States, and periodical world balance sheets will be prepared, showing for the principal countries of the world the production requirements, imports, exports, and net deficiencies or surpluses of the major crops and classes of live stock.

It is proposed to establish intimate cooperative relations with State departments of agriculture and State assessors. In this way greater accuracy will be secured and the aggregate expense to the States and the Nation reduced. As the value of reports depends not only on their completeness and accuracy but also on their quick availability, they will be issued very promptly and more frequently, summaries will be released on dates of issuance, and the Crop Reporter will be changed from a monthly to a weekly basis.

VALUE OF COMPLETE ESTIMATES.

It need scarcely be pointed out that county estimates are of great importance to the work of the county agents and the extension service in each State, to manufacturers and business men who supply farmers with equipment and machinery, to banks which furnish funds for financing crop production and movements, and to transportation companies for supplying cars when and where needed to move crops. They have already been made in a number of States. Preliminary estimates of acreages intended to be planted will en-

able farmers to determine whether their plans should be modified. Estimates of surpluses or deficiencies in the supplies of seed, fertilizers, and farm help tend to equalize both distribution and prices and to insure adequate farm production. Estimates of acreage, yield per acre, and production of each principal variety of a given crop, in addition to total production of the entire crop, will show the relative adaptability and productivity of varieties, and therefore will be of assistance not only to farmers, but also to seedsmen and to crop specialists and plant breeders of the State experiment stations and of the Federal Department of Agriculture. Those of crop damage by counties from insect pests and plant diseases will enable the entomologists and plant pathologists to work more intelligently in developing and applying remedies. Those of marketable surpluses on farms, or the portion of the crop sold from the farm and entering the channels of trade, will facilitate the satisfactory marketing and distribution of surplus production. Such estimates have been made for apples, peaches, potatoes, and truck crops, and they were promptly and effectively utilized by growers and marketing agencies.

Perhaps the most important feature of the enlarged program is that relating to live stock, which represents not only a farm investment of more than \$10,000,000,000 but also constitutes the meat supply of the Nation, a considerable portion of the export trade, a very important factor of successful farm management and economy, and 50 per cent of all farm sales. Yet for this important industry the bureau, with its inadequate facilities, has been able to estimate, once a year, only the gross number of animals on farms, the number of brood sows, and the total losses from disease and exposure. No attempt has been made in the past to estimate dairy and poultry production between censuses, the annual value of which amounts to approximately \$3,000,000,000. The great losses occurring yearly from drought and feed shortage in portions of the Great Plains and in limited areas of other sections might, to a considerable extent, be reduced by having definite and detailed information regarding the feed situation.

The expenditure of money for the execution of this program will clearly be an investment, which should be made without delay in order that agricultural and business interests may have the benefit of the improved service during the period of readjustment. It

should be borne in mind also that the proposals are in no sense experimental. Their feasibility and practical value have been fully demonstrated.

MARKETING AND DISTRIBUTION.

In the field of distribution, as well as in the field of production, the farmers of the Nation must assume the main tasks of improvement. The Government should furnish all possible aid in the way of information and suggestion, create favorable conditions under which production and distribution may take place, and especially see that the channels of trade are open and that abuses do not exist.

The present time is especially fruitful of proposals of a large and novel nature designed quickly to solve marketing problems. Recently measures have been introduced into the Congress proposing a private or a governmental agency of national range, with State and county subdivisions, to supervise, or even to direct, the handling or marketing of the Nation's farm products. The probability is that an undertaking of such character would break down of its own weight. There is no question that everything which can legitimately be done to eliminate waste in marketing and to promote orderly distribution should be done. But the views of the most experienced students of the matter seem to be that we must approach the problem in simpler terms, work along lines which have clearly proven to be feasible, and promote existing tendencies and practices.

Certainly, we can proceed further, by State, Federal, and individual action, in standardizing the production, the handling, and the packing of farm products, and in promoting the use of standard containers and proper storage on farms, in transit, and at market centers. We can continue to furnish assistance in the preparation and installation of accounting systems, and more extensively and accurately gather and furnish to the farmers of the Nation all pertinent statistical information. I need scarcely emphasize the paramount importance of making available daily to producers facts as to market prices, supplies, and demands. The market news services of the Department of Agriculture have already clearly proved their value. The department now conducts and operates an inspection service on fruits and vegetables covering 164 markets. It publishes reports on the supply, commercial movement, and prices of most of the important products and, in cooperation with 14 States, is issuing

exchange marketing lists which make known to county agents, breeders, and feeders in these States, where surpluses of live stock, feeds, and seeds are to be found. It is estimated that last year, through such service, the farmers in Iowa alone made local exchanges having an estimated value of \$1,500,000.

COOPERATIVE ASSOCIATIONS.

Particularly must the Federal and State agencies omit nothing to promote farmers' cooperative associations along right lines. Already, within a generation, many such bodies have appeared and rapidly expanded. It is estimated that they now market annually approximately \$1,500,000,000 worth of commodities. They are of very diverse forms and sizes. For the most part, where they have been successful they have centered their activities on some one product, or on related products, in a given area. The indications are that, with the continued success of these enterprises and with the proper educational effort and direction, they will develop even more rapidly in the future. Through bulletins, news articles, and lectures, the Department of Agriculture has endeavored to stimulate these efforts. It has furnished suggestions for State legislation governing their organization and, in cooperation with 23 States, it has employed trained specialists to advise extension workers, including county agents, and others, with reference to cooperative marketing.

As I have said, the rational program would seem to be to expand these activities, which have clearly demonstrated their value, to follow the scent as it were, and further to develop the machinery through which increased assistance may be furnished. There should be in every State one or more trained market specialists of the Department of Agriculture, working in cooperation with the proper State authority, to stimulate cooperative enterprises and to aid farmers in their marketing work by helpful suggestions as to plans and methods. These experts could very effectively aid the extension workers. County agents generally have the assistance of specialists in many other lines, but at present they have not the requisite aid in distribution. They can not be expected to be expert in all agricultural matters or to be omniscient. The department is requesting increased funds to make this extension possible and will take the necessary action promptly if the appropriations are made.

GOOD ROADS.

Good roads are essential to the prosperity and well-being of urban and rural communities alike. They are prerequisite for the orderly and systematic marketing of farm products, for the establishment of satisfactory rural schools, and for the development of a richer and more attractive rural life. Recognizing these facts, the Federal Government, through the passage of the Federal aid road act in 1916, inaugurated a policy of direct financial participation in road-building operations in the various States. This act appropriated \$75,000,000, to be matched by an equal amount from the States, for the construction of rural post roads over a period of five years, and \$10,000,000—\$1,000,000 a year for 10 years—for roads within or partly within the National Forests. It required each State to have a responsible central highway department with the requisite powers and funds. All the States have complied with the terms of the act, although it was necessary for them to enact additional legislation, or to amend their constitutions; to provide sufficient funds to match the Federal apportionment; and to strengthen existing central highway bodies or to create new agencies.

When these preliminary steps had been practically completed and the department and the States were about ready to proceed vigorously with the actual construction of roads, the United States entered the war. It soon became necessary greatly to curtail highway building because of the difficulty of securing transportation, construction materials, and the requisite services. After the armistice was signed, arrangements promptly were made for the active resumption and vigorous prosecution of road work in all sections of the country, not only with a view to repair the damage wrought by the heavy traffic forced upon our highways during the war, when maintenance operations were seriously interfered with, but also to provide adequate transportation facilities to serve the increased needs of agriculture and industry. Recognizing also that road-building activities would furnish suitable employment for many unemployed men during the period of transition from war to peace, the Congress at its last session, accepting the recommendation of the Department of Agriculture, appropriated \$209,000,000, in addition to the \$85,000,000 provided by the original act, for the extension of road construction in cooperation with the States, and also

made some important amendments to the act. The definition of the kind of roads that can be constructed was greatly broadened and the limitation on the Federal contribution for any one road was increased from \$10,000 to \$20,000 a mile. These amendments have greatly facilitated consideration of and action upon the road projects submitted by the State highway commissions. There is now no special obstacle to the construction, in the different States of the Union, of the roads which serve the greatest economic needs.

TRoublesome Limitations Removed.

The act, as amended, places only three limitations on the type of road which may be built, as follows:

(1) That the roads shall be "substantial in character." This means that the road must be so constructed that it will carry the prospective traffic with such maintenance expenses that the total annual charges will represent a reasonable expenditure for the public service rendered by the highway. It is to the interest of the States that the roads on which Federal funds are used be substantially constructed, because the law requires them, or their civil subdivisions, as a prerequisite to receiving further funds, to maintain properly all roads built with Federal aid. There is nothing in the law which restricts types of construction between narrower limits than those established by sound finance and good engineering practice.

(2) That the amount contributed from the Federal Treasury in connection with any road shall not exceed 50 per cent of its cost or \$20,000 a mile. The main thing is to build a road that will stand the traffic in the particular section of the country where it is constructed. The conditions in certain regions may require a heavy, comparatively high-cost type of road, while in others a lower cost type may meet all the requirements. Sentiment is growing throughout the country, even in the newer sections, in favor of more substantial roads. The people are beginning to realize that the expense of maintaining the lighter traffic types under heavy traffic is unbearable.

(3) That the road must be a "rural post road" as defined in the act as amended; that is, "any public road a major portion of which is now used, or can be used, or forms a connecting link not to exceed 10 miles in length of any road or roads now or hereafter used

for the transportation of the United States mails." Under the original wording of the law, Federal funds could be expended only on roads upon which the United States mails "now are or may hereafter be transported." This feature was the most troublesome to the highway departments of the various States. It required a definite determination in each case of the actual post-route status of the road, which necessarily involved delays in many instances. Under the new definition, very few important roads, if any, will be debarred from receiving Federal aid, if all the other requirements of the act are met.

Following the amendments to the act, the regulations governing its administration and the standards for plans, specifications, and estimates were modified, and one of the most successful former State highway engineers in the country was placed in charge of the Federal aid road work. He has at his disposal a large staff of local and district engineer aids, and no pains will be spared to provide any further Federal assistance that may be needed. An advisory committee, composed of representatives of the State highway departments, selected at the request of the department, by the American Association of State Highway Officials, with due regard to geographic considerations, also has been appointed to work in intimate touch with the Federal bureau, meeting with its officers at stated periods and at such other times as may seem desirable.

LARGE RESULTS FROM PRESENT FEDERAL LAW.

The record indicates that from July 1, 1918, to November 1, 1919, the department approved 1,345 road projects, involving the improvement of 12,159 miles, at an estimated cost of approximately \$181,143,644. Of this sum, approximately \$78,592,167 represents Federal funds. Since the passage of the Federal aid road act, 1,927 projects have been approved. These call for the construction of 18,596 miles of road at an estimated cost of \$225,267,847, of which about \$95,498,140 will be borne by the Federal Government. Gratifying progress also has been made in connection with the National Forest road work. From July 1, 1918, to November 1, 1919, 74 projects, involving 923 miles of road, were approved, and plans were completed for the improvement of 50 others, aggregating 946 miles.

The 1919 program for Federal aid road building is greater than any previous annual road-building accomplishment in this country. It is so great, in fact, that it undoubtedly will be necessary for many of the States to postpone until 1920 the expenditure of the Federal funds because of the necessity of developing experienced contracting and engineering organizations from the stagnant conditions brought about by the war. Under the terms of the act, the apportionment to a State for any one fiscal year remains available for expenditure until the close of the succeeding year. It is estimated that the funds already provided will be sufficient to finance next year a program more than four times greater than any that has ever been undertaken. As indicated, \$294,000,000 has been made available from the Federal Treasury, and it is roughly estimated that the State funds to be expended cooperatively on road projects under the terms of the Federal act will aggregate \$385,000,000.

It is also true that some States will expend large sums in excess of those to be used on cooperative projects and that their several subdivisions will provide large additional amounts. It is interesting to note that up to July 1, 1919, State bond issues aggregating \$224,800,000 had been authorized and approved by popular vote and that provision has been made for voting next year on proposals for the issuance of additional State road bonds to the extent of approximately \$314,000,000. During the present and the next fiscal year, there will be made available for road improvements at least \$1,000,000,000. Certainly, few laws, if any, have produced greater results, either in terms of expenditures for a good purpose or in terms of helpful legislation and machinery, than the Federal aid road act. It seems clear, in the circumstances, that the principal limiting factors in the 1920 program will be those of rail transportation for, and production of, suitable road materials, the contractors' organizations available, and the labor supply.

NO ADDITIONAL ADMINISTRATIVE MACHINERY NEEDED.

The suggestion has been made that the Federal supervision of highways should be taken from the Department of Agriculture and placed under a Federal highway commission. A bill having this purpose in view has been introduced in the Senate of the United States. It provides for a Federal highway commission of three, each receiving a salary of \$10,000 a year, whose duty, among other things, would be to establish, improve, repair, and

maintain a system of highways "to comprise not less than 2 per cent nor more than 5 per cent of the total highway mileage actually used as such in any State as ascertained by the commission hereinafter provided for, nor less than 2 per cent nor more than 4 per cent of the total highway mileage actually used as such in all of the States as ascertained by the commission, and affording convenient ingress to and egress from each State at not less than three points and connecting with highways forming part of the national highway system in adjoining States." The commission is given the power to select or establish the highways to be comprised in the system, after having requested the State highway departments to recommend routes, and to determine the order in which all or parts of such highways shall be constructed, reconstructed, improved, repaired, and maintained. The Federal Government is to assume the maintenance of these roads. The commission is furthermore empowered to take over the work of the Department of Agriculture relating to highway transportation, to construct and maintain buildings outside the District of Columbia, to operate housing and subsistence facilities and commissary stores for the benefit of its employees and others engaged on work under its direction, and to purchase, lease, operate, and maintain such motor and other transportation facilities as it may deem necessary in the performance of its duties.

In considering any proposal of this sort, certain fundamental considerations must be borne in mind: (1) The roads in each section of the country are of varying degrees of importance in the service which they render or may render to the particular locality, to the State, and to the Nation as a whole; (2) this is a big country and the traffic conditions and needs vary greatly from section to section; (3) the State highway departments, being in immediate touch with local conditions, are best able to classify the roads properly on the basis of the economic purpose which they may serve; (4) the Federal Government, under the Federal aid road act, is cooperating in the improvement of the roads of greatest importance, the classification of which is fixed by the State highway departments; and (5) when this classification has been carefully made and by agreement between the highway departments of adjoining States, the roads of first importance generally meet at State boundaries, and, therefore, become interstate highways

of nation-wide utility. The Federal Government, under the present law, is aiding the State highway departments in the classification of their roads on the basis of importance and needs, and Federal aid is rapidly being extended for their improvement, on projects submitted by the States and approved by this department.

The present machinery for supervising road construction is the Federal Bureau of Public Roads, one of the two most efficient agencies of the kind in the world, and the 48 State highway commissions. These, in effect, constitute an expert national commission, intimately in touch through its various parts with all sections of the Union, having no other purpose than that of serving the public interest. It is difficult to see what need there can be for additional or new machinery. Certainly, there is no necessity of creating a separate Federal highway commission or of substituting for the present cooperative program a plan which would commit or limit expenditure to a federally owned and maintained highway system. Such a plan would not meet present needs. There is as yet too much pioneer work required to trust the working out of proper highway policies to a small Federal commission.

Very properly the Federal aid road act places on the highway authorities of the several States responsibility, in large measure, for selecting the roads to be constructed. Obviously the local authorities are in a better position to judge what roads would serve the largest economic needs than any group of men sitting in Washington would be. It is the duty of the Federal Bureau of Roads, with its district engineers, to see that the provisions of the law are complied with. It is giving, and will continue to give, all possible assistance to the State authorities in all their technical problems, as well as in the planning of State systems and in the classification of roads. It has been the policy of the department from the outset, in order to prevent haphazard action, to have the State highway authorities prepare and present tentative State systems of roads. It was apparent that rigid systems not subject to modifications as conditions might require would be inadvisable. Each State has worked out a system and, in general, it is being followed in the development of projects and the construction of roads. In a number of instances systems in general terms have been adopted by the legislatures. In formulating these systems, the engineers are giving due regard to interstate connections, that is, to roads connecting the

system of one State with that of another, and as progress is made the construction of through roads will follow as a matter of course.

PROPOSED CHANGE WOULD MEAN LOSS.

I am convinced that nothing material would be gained by the proposed change. Much would be lost. Many complications would be introduced. The creation of a commission would entail unnecessary additional administrative expenditures and the commission could not do anything that can not be done more effectively by the existing cooperative machinery. I think it is not too much to say that there is a minimum of friction in the relations of the State and Federal authorities and that the majority of the State highway agencies are satisfied with the present arrangement and do not wish a change.

There would also be a radical change of policy. I am of the opinion that the people of the States will not be willing to substitute for the present policy of developing road systems on the principle of serving the broadest economic needs that policy advocated by those whose interest is in main or trunk line automobile roads primarily for touring purposes. The largest service will be rendered, not only to farmers but also to urban people, by following the principle of constructing roads of the greatest economic importance, selected after careful consideration by the State agencies having adequate knowledge and approved by the Federal department. It seems to me clear also that, as the work proceeds, we shall have roads which will be equally serviceable not only to those interested immediately in long-distance automobile travel and motor-truck transportation but also to those interested in getting their farm produce to the market in the easiest and most effective manner and in the transportation of the mails. I clearly recognize the vast growth and importance of the motor-propelled vehicle passenger and freight traffic. It is estimated that we have 87 per cent of all such vehicles in the world, and we are only at the beginning of their use; but I am satisfied that the development of highways along present lines rather than along the lines proposed will result in their more extensive use. I have no prejudice against any sort of road except a bad road, or against any sort of construction except wasteful and unsubstantial construction. If traffic conditions

require heavy construction, then I am in favor of it; and in any case, under the present law, the road must be substantial.

The road movement is growing very rapidly. The Federal aid road act has done much to promote it. Experience has brought about amendments to the law and helpful changes in administration. Comprehensive road programs have been inaugurated. They are being pushed vigorously. They will result, in a shorter time than most people imagine, not only in a network of good substantial roads in the various States of the Union, but also in the requisite interstate highways.

Why at this stage introduce complications and embarrassments? Why should not the friends of the movement for roads to serve the people cooperate? It is difficult for me to see why all who are animated by high public spirit in their thinking concerning highways should not cooperate in the development of present programs and in the perfecting of the existing processes and machinery, instead of attempting to overthrow them. I believe that many of those who are backing the proposed change do not know the facts and are not aware of existing conditions and possibilities.

CONTINUATION OF FEDERAL APPROPRIATIONS.

The period covered by the original Federal aid road act and its amendments will expire with the fiscal year 1921. The results to date clearly point to the desirability of continuing the policy of Federal participation in road building. If this is to be done, it is essential that a decision be reached at an early date, so that the States may be able to make the necessary financial provision and the State and Federal departments make the requisite administrative arrangements. If the financial condition of the Nation permits it, I believe it would be good policy to make available from the Federal Treasury, to be expended under the terms of existing legislation, \$100,000,000 for at least each of the four years beginning with the fiscal year 1922.

PAST ACTION AND FUTURE STEPS.

The promotion of agriculture and the betterment of rural life have, for many years, received the earnest attention and support of State and Federal authorities. Several generations ago the founda-

tions were laid for the two great agricultural agencies, the land-grant colleges and the Federal Department of Agriculture, which have no rivals elsewhere in the world. The State colleges steadily developed until in 1918 they had plants and endowments valued at \$184,400,000, annual incomes aggregating \$47,700,000, and resident and short-course students numbering 123,000, of whom 45,000 were in agricultural courses. Their student body has greatly increased this year. They are now engaged, in cooperation with the Department of Agriculture, in agricultural extension work involving an annual expenditure of more than \$14,000,000. They have been conducting investigational and educational work for many years and have placed in all parts of the Union farm leaders with scientific and practical vision. The Federal Department of Agriculture, whose personnel now numbers more than 21,000, is expending from all sources during the current year \$41,800,000, aside from the \$294,000,000 made available by the original and amended Federal aid road act for the cooperative construction of roads.

As has been repeatedly pointed out, the last five or six years have been especially fruitful of legislation and administrative action looking to the improvement of production and distribution. The principal items are the following:

(1) The Bureau of Markets, excelling in the character and extent of its activities any other similar existing organization.

(2) The Cooperative Agricultural Extension Act, the object of which is to disseminate information among the farmers, mainly through trained agents. As has been indicated, there is now expended annually, from Federal, State, and local sources, more than \$14,000,000 for work contemplated by this act.

(3) The Cotton Futures Act, with amendments, under the provisions of which standards for cotton have been established, the operations of the futures exchanges supervised, and the sale of cotton put on a firmer basis.

(4) The Grain Standards Act, which aims to bring about uniformity in the grading of grain, enable the farmer to obtain a fairer price for his product, and afford him a financial incentive to raise better grades of grain.

(5) The Warehouse Act, which authorizes the Department of Agriculture to license bonded warehouses and which makes possible

the issuance of reliable and easily negotiable warehouse receipts, permits the better storing of farm products, increases the desirability of receipts as collateral for loans, and promotes the standardizing of storages and of marketing processes.

(6) The Federal Aid Road Act, as amended, which made available \$294,000,000 for cooperation between the Federal and State Governments in the construction of rural roads. It has conduced to the establishment of more effective highway machinery in each State and strongly influenced the development of good road building along right lines. It will stimulate larger production and better marketing, promote a fuller and more attractive rural life, add greatly to the convenience and economic welfare of all the people, and strengthen the national foundations.

(7) The Federal Reserve Act, which authorized national banks to lend money on farm mortgages and recognized the peculiar needs of the farmer by giving his paper a period of maturity of six months.

(8) The Federal Farm Loan Act, which created a banking system reaching intimately into the rural districts and operating on terms suited to the farmer's needs. It is attracting more capital into agricultural operations, bringing about a reduction of interest to farmers, and placing upon the market mortgages which are safe investments for private funds.

(9) The Vocational Education Act, which, among other things, provides for cooperation with the States in training teachers of agriculture and in giving agricultural instruction to pupils in secondary schools.

Among other steps which should be taken are the following:

(1) The building up, primarily under State law, of a system of personal credit unions, especially for the benefit of farmers whose financial status and scale of operations make it difficult for them to secure accommodations through the ordinary channels.

(2) Expansion of existing facilities and activities for aiding farmers in marketing, including especially the extension of the market news and food-products inspection services and the assignment of trained market specialists to each State, in cooperation with the State authorities, to stimulate cooperative enterprises and to make helpful suggestions as to plans and methods.

(3) Continuation of the present policy of Federal participation in road building, through the appropriation, if the financial condition of the Nation permits it, of \$100,000,000 for at least each of the four years beginning with the fiscal year 1922, to be expended under the terms of existing legislation.

(4) The regulation and control of stockyards and packing houses.

(5) Federal legislation further to protect consumers against misbranded, adulterated, and worthless feeds entering into interstate commerce.

(6) Similar legislation dealing with fertilizers.

(7) Increased support by States for rural schools and more definite direction of their instruction along lines related to rural problems and conditions.

(8) The requisite legislation for the improvement of the sanitary conditions in rural districts and for the building up of the needed hospital and medical facilities.

NEED FOR BROAD SURVEY OF RURAL CONDITIONS.

Present conditions, and particularly present states of mind, indicate the need of a fresh, broad survey of rural life, of its special problems, and of its relationships. It should be viewed as a whole. A comprehensive flexible program should be developed for the guidance of the different agencies, each of which has its peculiar functions and responsibilities. Furthermore, the principles and purposes governing agricultural life and agencies should be set forth for the education of the American public, particularly the urban part of it. The Nation as a whole needs a fuller appreciation of its basic industry, and a more definite sense of direction of its efforts to foster it. Many agencies are now following more or less well defined, helpful plans of their own devising, but these are at best piecemeal, and there is confusion of leadership and objectives. A program made by any one element would be partial and unsatisfactory. We should have a meeting of minds of all those directly concerned, of farmers, of agricultural leaders, and of business men.

You have already indicated your intention to call a conference at which there will be not only a generous representation of farmers but also of agricultural agencies and organizations and of business interests which have an intimate relation to farm problems. I believe that, because of changed conditions here and elsewhere, of existing uncertainties, and of disturbed states of mind, this confer-

ence should be called at the earliest possible date. It may be that, as one outcome of it, the creation of a rural life commission, with a temporary or a permanent status, will be determined to be in the public interest. Certainly, the best means of fostering our basic industry can not too frequently receive definite consideration by the best minds of the Nation.

Respectfully,

The PRESIDENT.

D. F. HOUSTON,
Secretary of Agriculture.

REPORTS OF CHIEFS.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

UNITED STATES DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
Washington, D. C., October, 11, 1919.

SIR: I have the honor to submit herewith a report of the operations of the Weather Bureau during the fiscal year ended June 30, 1919.

Respectfully,

C. F. MARVIN,
Chief of Bureau.

HON. D. F. HOUSTON,
Secretary of Agriculture.

POST-WAR CONDITIONS.

With the close of the fiscal year and the passing of war conditions the Weather Bureau finds itself face to face with post-war conditions of more serious character even than the difficulties imposed by the war. It seems appropriate at this time to state briefly the status and functions of the Weather Bureau because applied meteorology as never before in history has come to be recognized as a highly important factor and guide in the conduct of almost every activity of any consequence of the Nation. Never before in any previous war did the science of meteorology play any important part or have a place in the program of military and naval organizations and operations. Now it is regarded as indispensable and is destined to become a permanent feature of each arm of the service.

Created in 1870 as a part of the Signal Corps of the United States Army by a joint resolution of Congress "to provide for taking meteorological observations at the military stations in the interior of the continent and at other points in the States and Territories of the United States and for giving notice on the northern lakes and on the seacoast, by magnetic telegraph and marine signals, of the approach and force of storms," its network of stations soon embraced the entire United States.

Subsequently the designation of the service was changed to the Weather Bureau, which, by act of Congress approved October 1, 1890, was transferred from the War Department to the Department of Agriculture and its duties and functions defined in the following language:

The Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, shall have charge of forecasting the weather; the issue of storm warnings; the display of weather and flood signals for the benefit of agriculture, commerce, and navigation; the gaging and reporting of rivers; the main-

tenance and operation of seacoast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation; the reporting of temperature and rainfall conditions for the cotton interests; the display of frost, cold-wave, and other signals; the distribution of meteorological information in the interest of agriculture and commerce; and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or are essential for the proper execution of the foregoing duties.

This organic act, with interpretations and extensions by subsequent annual appropriations, assigns to the Weather Bureau the entire domain of meteorology, including the duty of preparation and issue of forecasts and warnings of weather, storms, cold waves, heavy snows, floods, and the stages of rivers, all in the interest of commerce, agriculture, and navigation. At present it maintains over 200 fully equipped meteorological stations, and about 1,400 substations classified as special meteorological, river, storm-warning, hurricane, marine, cotton-region, corn-and-wheat-region, fruit, cranberry, and fire-weather warning stations. In addition to these the Bureau maintains, in connection with its climatological work, about 4,500 stations known as cooperative stations, the equipment being furnished by the Bureau and the observations being taken by public-spirited citizens who render gratuitous service. Its cooperative work extends to practically every ocean of the globe, and the masters of many vessels (the number was greatly reduced by the war, but is now on the increase) fill out our forms of daily meteorological observations on every voyage, to be forwarded on arrival in port. Before the war daily observations received by cable and otherwise from selected stations over the entire Northern Hemisphere were collected and published. Negotiations to restore this exchange are under way. A highly trained, efficient, and experienced personnel of over 800 commissioned employees, helped by about 1,400 who receive a small compensation for the regular performance of specific duties, conducts the work of the Bureau, and in addition the marine and cooperative observers constitute a host of nearly 6,000 public-spirited individuals who serve gratuitously. Such, in brief, is the machinery and organization of the Weather Bureau.

While the Bureau is best known to the public through the issue of its daily forecasts, maps, and bulletins, there is no doubt that its greatest value in an economic sense consists in the immense saving effected by its special warnings, as of storms and hurricanes for the benefit of marine interests, warnings of floods that occur on the principal rivers, warnings of cold waves which accomplish protection to property and food stuffs liable to damage by injuriously low temperatures, and warnings of frost and freezing weather for the benefit of the fruit, sugar, tobacco, cranberry, market gardening, and other interests.

Its duties and authorities by law are broad and comprehensive, and post-war conditions bring it new and important obligations and responsibilities which it is fully alert to recognize and eager to discharge. With the experience and traditions of nearly 50 years to its credit, the Bureau is in a position to render practically every service of a meteorological nature which may be required of such an agency and at an economy of expenditure of public funds which can not be surpassed, or even equaled, by any new agency.

A few only of the post-war problems and demands in the administration of the affairs of the Weather Bureau will be mentioned here.

METEOROLOGY AND AERONAUTICS.

From a phenomenal development under the stimulus of war necessities the navigation of the air is rapidly extending to its civil and commercial or industrial stage. Flying in ignorance or disregard of meteorological conditions and warnings is at times suicidal and destructive of costly property. Even before flying increased so greatly within the United States the Weather Bureau inaugurated a service of flying forecasts, effective December 1, 1918, which is conducted in cooperation with the Chief Signal Officer of the Army and for the benefit at first of the Army training posts and the aerial mail service of the Post Office Department, and later destined to be extended to all flying in general. Much development work is needed to make this service the most effective possible, all of which may be accomplished, as flying develops, through existing agencies and channels of cooperation between the public and the branches of the Government concerned.

METEOROLOGY FOR MILITARY OPERATIONS.

Closely allied to meteorology for aeronautics, the experiences of the war have created a demand for a service to supply information for artillery, gas warfare, and other kinds of military operations, each in its way different. The influence of winds upon the flight of projectiles has long been recognized, but in the past methods of observing the actual motions of the free air in the various altitudes were little known and less used, consequently the allowance for wind in the older formulæ of the artillerists were largely academic or mere approximations, whereas nowadays the ballistic wind is not a matter of guess or estimation, but of definite and direct observations by meteorologists employed for the purpose and using pilot-balloons or other aerial apparatus which meteorologists have developed and employed in the advancement of their own science.

On a peace-time basis these needs are being met by cooperative work and arrangements existing between the Chief of the Weather Bureau and the Chief Signal Officer of the Army, as a result of which a limited number of stations are maintained by the Army, while others constituting a useful coordination of points are established and maintained by the Weather Bureau. Observations at these stations consist chiefly of the flight of small rubber pilot-balloons. The results are used locally as required and telegraphed to the central office of the Weather Bureau for the use of the official forecasters in the issue of flying advices and other information.

MARINE METEOROLOGICAL OBSERVATIONS.

The submarine menace brought on with the war soon terminated the program of observations which merchant vessels plying the several oceans of the globe were long accustomed to furnish with the object of supplying data and information concerning the climate and meteorology of the oceans for publication as aids to navigation (marine) on the pilot charts of the Hydrographic Office. This serv-

ice is being restored gradually, and its importance is enhanced on account of the policy of extending the merchant marine of the United States, and also extensive navigation of the air over the oceans, which the future is sure to see accomplished.

Details of the major activities and work of the Bureau follow:

FORECAST SERVICE.

The general forecast service continued in operation as in the past several years. This plan consists of: (a) The Supervising Forecaster at the central office, Washington, D. C., who has general charge of the forecast work of the Weather Bureau and regularly makes the day-to-day forecasts and special warnings for the Washington forecast district and warnings of storms and dangerous winds for the Great Lakes, the Atlantic and Gulf coasts, and the West Indian waters; (b) district forecasters at the Chicago, New Orleans, Denver, and San Francisco forecast district centers, who have to do with the preparation and dissemination of forecasts and warnings for their respective districts; (c) a district forecaster at San Juan, P. R., who has charge of the issue of forecasts and warnings for that part of the West Indies lying east of longitude 70° west; (d) a district forecaster at Juneau, Alaska, who issues daily forecasts for the Juneau district of southeastern Alaska throughout the year, and for the lower Tanana Valley during the period of low temperatures; and (e) local forecast officials located in many cities of importance who prepare forecasts of weather, temperature, and wind for their respective limited regions. The forecast districts with headquarters at San Juan and Juneau were organized during the fiscal year ended June 30, 1919; otherwise there was no change in the general plan of organization.

FORECAST OFFICIALS.

The officials assigned to forecast service are selected only after long preliminary training and through competitive tests that extend through one or more years. It is necessary that the officials engaged in this work have a fundamental training in the laws of atmospherics and also that they be temperamentally fitted for the work, which, at times, is extremely arduous and requires the constant attention of the one engaged therein. In addition to the officials that are actually engaged on this work, there are of the younger men of the Bureau approximately 40 who engage in what is termed "practice forecasting," fitting themselves to later become local forecasters and yet later, in the event of special aptitude and success, to become assistants to district forecasters. This system of training forecasters must necessarily rest in the Weather Bureau, for there is no outside institution of learning where one might perfect himself in the art of weather forecasting.

FORECASTS AND WARNINGS.

The forecasts that are regularly issued by the Bureau are adapted to the many varied demands for them. In general, they consist of the following:

(a) Day-to-day forecasts, for 36 to 48 hours in advance, of the general weather, temperature, and wind conditions for the various

State units. These forecasts are issued twice each day, a. m. and p. m., at approximately 9:30 o'clock. The morning forecast is given general distribution through the display of weather and temperature flags, the telephone, printed cards and bulletins, and the afternoon press; the evening forecast is distributed mainly through the various press associations for appearance in the morning press.

(b) Weekly forecasts, that are issued Saturday of each week for larger areas than the day-to-day forecasts, and set forth the expected general conditions of the weather for that period in advance. These forecasts are disseminated largely through the press, but also through mailed cards and bulletins.

(c) Local forecasts, that are issued daily by the officials of the more important Weather Bureau stations for their respective regions. These include a statement as to the probable weather, temperature, and wind, and, during the winter months, the probable minimum temperature is made a part of the forecast.

(d) Shippers' forecasts, which are regularly made during the months when temperatures likely to be injurious to shipments of perishable goods and produce occur. These forecasts are prepared and issued by the local forecasters at many of the regular Weather Bureau stations.

(e) Special forecasts that are issued from time to time as occasion requires, and some of these are given special designations, as, for example: "Fire-weather warnings," for the forest regions of the West; "Orchard forecasts," for the guidance of spraying operations for insect pests and fungi, and of heating operations to prevent frost injury. Moreover, special forecasts are regularly issued for the cranberry industry of Massachusetts, New Jersey, and Wisconsin; and for various other industries that are partially or wholly dependent on accurate forecasts of weather and temperature changes.

(f) Day-to-day forecasts of the weather and winds along the trans-Atlantic steamship lanes eastward from the Atlantic ports to the Grand Banks of Newfoundland are issued for the guidance of vessel masters.

(g) Day-to-day wind and weather forecasts for the Atlantic and Gulf coasts are issued each day and transmitted to vessels at sea through naval radio. In addition to the forecast there is included in this daily message the prevailing weather and wind conditions at ports along the Atlantic and Gulf coasts and a statement as to the position of any atmospheric disturbance and its direction and speed of movement and intensity.

(h) Aviation forecasts are made regularly each day for the Post Office Department and the United States Army Air Service and the United States Naval Air Service. This service is conducted in a rather limited way as yet, but the general plan of the Weather Bureau aims to effect its development as rapidly as funds and the extension of aviation justify.

(i) Warnings are obviously issued only at specified times, but many of them are so important that when conditions arise which require their issue other lines of work give way in order that the warnings and advices may be placed before commercial and other organizations that may be benefited thereby. Warnings are issued for cold waves, heavy snows, gales, frosts, local storms, floods, winds dangerous to

navigation on the Great Lakes, the oceans, the Gulf of Mexico, and the Caribbean Sea, and for hurricanes. There can be no question but that this service saves many lives, and that property to the value of millions of dollars has been protected and saved through the prompt issue of these warnings by the Weather Bureau.

FUTURE DEMANDS.

With the wider recognition now accorded applied meteorology, increased demands are being made for information and forecasts. Advances of various kinds and forecasts are already being supplied the Air Services of the Army and the Navy and the Post Office Department, and it seems altogether probable that the growing demands for information and forecasts of a meteorological character will soon make necessary a new branch of forecasting planned to care primarily for the interests of aerial navigation.

RECENT EXAMPLES.

During 1919 there were two notable cases of the importance of accurate meteorological information and forecasts in connection with aerial navigation. The one was that of the trans-Atlantic seaplane flight by the United States Navy in May, and the other that of the visit of the British dirigible, the R-34, to our country during July. In both these instances the fullest cooperation on the part of the Weather Bureau was requested by the United States Navy. Complete synoptic meteorological reports were placed at the disposal of the officials of the Navy, and in addition the forecaster on duty prepared and issued forecasts based on the 8 a. m. and 8 p. m. regular observations for the commanding officers of these operations.

THE TRANS-ATLANTIC SEAPLANE FLIGHT IN MAY, 1919.

The start of the trans-Atlantic seaplane flight (United States Navy) was made from Rockaway the morning of May 8, two of the planes, the NC-1 and NC-3, reaching their destination, Halifax, the afternoon of the same day. The NC-4 developed engine trouble and put into Chatham, Mass. The forecast issued the morning of the 8th was as follows: "Moderate northwest and west winds. Fair weather to-day. Friday; fresh north to east winds, cloudy weather with rain over southern half of course." The evening of the 9th the following forecast was made for the seaplanes between Halifax and Trepassey Bay, Newfoundland: "Weather favorable for flight Saturday. Gentle variable winds. Fair weather. Wind velocity less than 15 miles an hour." The morning of the 10th the forecast for the same course read: "Fair weather Halifax to Newfoundland. Gentle variable winds, except moderate west and northwest off south coast of Newfoundland." The flight from Halifax to Trepassey Bay was made on the 10th and the two seaplanes making it reached their destination the afternoon of the same day. In the meantime the seaplane NC-4, at Chatham, Mass., had made ready for a renewal of the flight to Halifax, but it was held there for several days because of adverse wind and weather conditions. On the evening of the 13th the following forecast was sent the commander of the seaplane NC-4 at Chatham, Mass.: "Conditions favorable for start from Chatham

for Halifax Wednesday morning (the 14th). Moderate to fresh westerly winds and fair weather." The flight was made to Halifax on the 14th under favorable conditions, and from Halifax to Trepassey Bay on the 15th, the advices sent to the commander of the NC-4 assuring him of favorable wind and weather conditions. On the 15th (Thursday) the following forecast was sent to the commander of the seaplanes at Trepassey Bay, Newfoundland: "Wind and weather conditions over the course (Newfoundland to the Azores) will improve during Friday and Saturday. Wind will be west and fresh and possibly strong. Weather will be fair. Above based on incomplete reports from the ocean. Advise start by Friday night." On Friday the following forecast was sent: "Surface winds fresh and possibly strong west-southwest and upper winds fresh to strong west over course between Newfoundland and the Azores; some clouds, fair visibility, and rising pressure. Conditions favorable for start." The seaplanes left Trepassey Bay the afternoon of the same day for the Azores. The NC-4 reached the Azores the late forenoon of the following day, while the NC-1 and the NC-3 landed in the vicinity of the Azores, but were unable to rise from the water and resume their flights

THE VISIT OF THE BRITISH DIRIGIBLE, THE R-34, JULY, 1919.

The Weather Bureau was called on for detailed information and forecasts before, during, and after the visit of the R-34 to the United States in July, 1919. The first call for information and forecasts was from the R-34 by radio when she was in the vicinity of Newfoundland, and then and after, until she had reached midocean on her return to Great Britain, the latest meteorological information and forecasts were always at the disposal of the commander of this craft. The following letter, addressed to the Chief of the Weather Bureau, was received from the Secretary of the Navy concerning the work of the Weather Bureau in connection with the visit of the R-34 to our country:

The work done by the Weather Bureau before, during, and after the visit of the British dirigible R-34 has been keenly appreciated by the Navy Department, and by the British officers connected with this flight. The reports were most reliable and the last report sent by Maj. Bowie on the evening of July 10, undoubtedly was the prime agent in the safe departing of the ship.

Also there was received the following letter from the British air attaché in appreciation of the work of the Weather Bureau in connection with the flight of the R-34:

Permit me to thank you, on behalf of the Air Ministry for the very distinguished part you played in the success which attended the visit of the R-34. It is claimed that meteorology is the handmaiden of aeronautics, but I think that does not show the science enough respect. At any rate, you, by your assiduous attention to, and reading of, the weather during the visit contributed more than a fair share to the success attained.

TROPICAL STORMS.

Only one tropical storm of sufficient importance to justify the display of hurricane warnings occurred during the year, namely, that of August 1-6, 1918. This storm moved northwestward across the Caribbean Sea and Gulf of Mexico, and struck the Louisiana coast

about 30 miles east of the mouth of the Sabine River, moving thence inward about 80 miles to northwestern Louisiana, where it was dissipated. It passed over Lake Charles and Gerstner Field, La., developing considerable violence, the wind attaining a velocity of about 100 miles an hour. Thirty-four deaths were reported as being due to the storm and the number of persons injured as more than twice that number. The damage to property was roughly estimated at \$5,000,000. Hurricane warnings in advance of the storm were ordered for the Louisiana and Texas coasts from Galveston east.

SPECIAL METEOROLOGICAL STATIONS.

As an aid to the forecast service in Alaska arrangements were made for the establishment of three special meteorological stations at Atka, Akiak, and Noorvik, Alaska, to report twice daily by radio.

HIGHWAYS WEATHER SERVICE.

A new project, designated "Highways weather service," was formally authorized during the year. In the carrying out of this project certain central stations receive reports of the conditions of the roads in the surrounding region or over certain main highways, and publish the same on their bulletins and in the press. In cases where the stations are centers of a corn-and-wheat or cotton-region service the reports of road conditions are obtained by telegraph without additional expense by the addition of a word indicating the conditions of the road to the daily report from the substations. In other instances they are obtained by mail by means of franked postal cards furnished to persons who are willing to cooperate with the Bureau in this service. Projects were in operation during the past winter at some 15 stations in 11 States, but at all but four of these it was a winter service only and was discontinued in the spring, to be resumed the coming winter. Although still in a tentative stage the service has great possibilities and is likely to be largely extended in the future. It has proved very popular where it has been in operation, the official in charge at one station stating that he has as many calls for road data during the day as for the weather forecasts.

RIVER AND FLOOD WARNINGS.

The flood service of the Weather Bureau functioned properly, not only as to the issue of timely notices of the coming of floods but also in the daily statement of river conditions throughout the country.

The floods of the year were largely local and much less severe than in many previous years.

During threatening conditions which obtained for a time along the Mississippi River from Keokuk, Iowa, southward to Louisiana, Mo., information was furnished that proved to be of great practical utility in the organized effort to strengthen the levees along that section of the stream.

In the drainage investigations of the department and in many private enterprises in connection with river improvements the river and flood service has contributed valuable information both to agricultural and commercial interests along the great rivers of the country.

INSPECTION OF RIVER STATIONS.

Owing to the unprecedented demand for engineers, it has not been possible to obtain from the outside persons having the necessary skill and experience to correct irregularities which invariably creep into the work of river-gaging stations unless the work is frequently inspected.

As a temporary expedient an employee of the Washington office was detailed for a part of his time to field work in connection with the installation and upkeep of river gages. It was not possible in this way, however, to care for more than the most pressing cases. A return to the prewar basis of having persons of engineering ability available at central points for service in keeping the system of river-gaging stations up to standard is urgently needed.

CHANGES IN DISTRICT CENTERS.

No new river districts were organized during the year, but the charge of the Kansas River was transferred from Kansas City, Mo., to Topeka, Kans., largely for administrative reasons.

SNOW SURVEYS IN HIGH ALTITUDES.

The activities of the Bureau in determining the depth and density of the snow cover of high altitudes in certain drainage basins of the West were naturally restricted to the most urgent and promising cases. These were the White Mountain region of Arizona draining into the Roosevelt Reservoir and on the headwaters of the Walker River of Nevada.

FORMULÆ FOR FLOOD FORECASTING.

Studies leading to the formulation of rules for forecasting floods almost wholly from the physical data of rainfall have been completed during the year for the Asheville (N. C.) district.

COOPERATION.

Progress was made on the following-named specific projects during the year:

1. The collection of rainfall measurements in the mountains of Los Angeles and San Bernardino Counties, Calif., in cooperation with the local county officials.

2. The Wagon Wheel Gap Experiment Station in cooperation with the Forest Service of the department. This important project has now run for eight years, and a mass of unique data has been collected to establish, if possible, hitherto unknown facts concerning the relations between weather conditions and stream discharge on forested watersheds. The experiment has reached its second stage, in which one of the two watersheds will be denuded of its forest and observations continued for a further period of years under the changed conditions. A detailed study of the data for the first stage of the experiment is far advanced, and the future observations are looked forward to with great interest.

STATIONS AND OBSERVATIONS.

NEW WEATHER BUREAU BUILDINGS.

After considerable unavoidable delays due to war and unsettled business conditions, the new Weather Bureau observatory and telegraph office building at Cape Henry, Va., was completed and accepted under date of September 8, 1918. This station was fully equipped with steel towers and lanterns for storm warning displays, and a small electric light plant to provide illumination for displays, vessel-signaling, and office purposes has proved very satisfactory. The new building was erected on the Weather Bureau reservation comprising 15,000 square feet of ground on beach front at the foot of Forty-third Street, where the location is much more advantageous than that previously had for many years on the lighthouse reservation. The old building is retained for use of the assistant observers.

CHANGES AT REGULAR STATIONS.

Narragansett Pier, R. I., station discontinued August 17, 1918. Weather building and reservation placed in hands of a caretaker.

Buildings and reservation at Mount Weather, Va., also remain in possession of caretaker.

On October 1, 1918, the important meteorological city substation, Central Park, New York, in the Army Building, near Sixty-fifth Street, East, maintained continuously for about 50 years past under local supervision, was removed to, and installed in the remodeled Belvidere Tower building, near the Eighty-first Street, West, entrance to the Park, and re-equipped as a permanently established substation of the Bureau.

Completion of a Federal building at New Haven, Conn., in which accommodations were provided by the Treasury Department, enabled the Bureau to effect removal thereto February 15, 1919, and save rental heretofore paid for quarters in a private building.

Notwithstanding the general increase in rentals throughout the country during the last two or three years, it has been possible to effect a considerable saving to the Government by reason of the 5-year renewal clause in leases whereby the Bureau was able to retain occupied quarters at prewar prices. Leases involving \$6,466 at the old rate, which now expire by limitation at seven stations where increase is demanded, required renewal at a total increased cost to the Bureau of \$1,556 for the next fiscal year, or about 24 per cent of the total amount paid for such rentals. One serious incident of exorbitant increase in rental compelled the Bureau reluctantly to move its station at Topeka, Kans., to quarters in a new rented building. The following statement shows the present status of Weather Bureau offices at field stations outside of Washington, (not including Narragansett Pier or Mount Weather):

Free quarters and accommodations:

In Observatory buildings, owned and controlled by the Weather Bureau	45
In State University buildings	5
In Federal buildings	72

Total free of rental..... 122

Rented buildings, etc., owned by individuals or corporations:

In office buildings-----	80
In buildings with grounds, aerological and special meteorological stations-----	19
Total number rented buildings partly or wholly occupied-----	99
Total-----	221

COOPERATION.

The Weather Bureau is always ready to cooperate to the fullest extent possible, and during the war, at Springfield, Ill., the entire second floor of its building was turned over for extended use by the Internal Revenue Service. At Parkersburg, W. Va., Weather Bureau quarters in the Federal building were changed to better accommodate additional employees of the Treasury Department. At Sand Key, Fla., at the request of the Secretary of the Navy, the station and equipment were transferred to that department October 26, 1918, by order of the President, under the authority of the Overman Act, and returned to the control of the Weather Bureau July 1, 1919.

TELEPHONE SERVICE.

In connection with its prompt and wide dissemination of storm warnings and general meteorological information, the Weather Bureau probably is the most extensive user of telephones of any branch of the Government, and at its more than 220 central field stations has direct wire connections with local telephone exchanges. An authorized allotment of about \$14,000 was made for this local telephone service for the fiscal year ended June 30, 1919, and the increased local rates promulgated in the Postmaster General's Order No. 2940, effective May 1, 1919, called for an almost complete readjustment, together with an added and wholly unexpected charge against our appropriations for 1918-19. For next fiscal year the total cost of this service is likely to reach \$17,000.

TELEGRAPH CONTRACTS.

For the prompt handling of meteorological reports and weather information over the greater part of the Northern Hemisphere the Weather Bureau has necessarily maintained for many years past formal annual contracts, arranged under special authority of law, with all of the more important telegraph, telephone, and submarine cable companies, including also wireless commercial companies, through cooperation with the Naval Communications Service. By order of the Postmaster General, dated June 7, 1919, Weather Bureau contracts for next fiscal year and during Federal control were made exempt from increase of rates, but this affects only contracts entered into by the central office at Washington. An opinion was also obtained that increased rates were not applicable for wire and battery service leased for maintenance of local recording river gages and similar self-registering equipment used by the Weather Bureau.

INVESTIGATIONS IN VOLCANOLOGY.

The act making appropriations for the Weather Bureau for the fiscal year ended June 30, 1919, contains authority for investigations in volcanology and appropriates \$10,000 therefor. Provision for

this project was included in a supplemental estimate submitted to Congress for the fiscal year 1917, but was not allowed. The estimate was not repeated for the fiscal years 1918 and 1919, but was inserted on the initiative of Congress itself for the current fiscal year. The primary purpose of the appropriation is to conduct investigations in volcanology at Kilauea Volcano, on Hawaii Island, of the Hawaiian group, with the expectation that they may be extended later in Alaska and other places in the United States possessions where active volcanoes exist. The site of the volcano and extensive adjacent territory has recently been included in a national park.

Investigations have been conducted at Kilauea since 1912, first under the auspices of the Massachusetts Institute of Technology, and since 1913 by the Hawaiian Volcano Research Association, which is composed principally of prominent citizens of Honolulu.

The Weather Bureau took formal control of the work at Kilauea on February 15, 1919. Prof. Thomas A. Jaggar, jr., formerly of the Massachusetts Institute of Technology, who has been in charge of the investigations since their inception, has been appointed volcanologist and will continue in immediate charge.

The buildings, grounds, instruments, and equipment belonging to the Hawaiian Volcano Research Association were transferred to the control of the Weather Bureau under the terms of a long-time lease. Prof. Jaggar and his assistants will reside in the observatory buildings, and the major part of their work will be conducted at the Kilauea Volcano, although simultaneous studies of the activities of near-by volcanoes, especially Mauna Loa, will be made as far as practicable.

The program of work at present contemplates little more than the maintenance of the systematic observations of the volcano, with some possible extensions in the way of a seismic survey of the vicinity. No more than this can be undertaken with present funds, but as national affairs become more stabilized under peace-time conditions the opportunity offered here of conducting extensive investigations in the field of volcanology will no doubt be fully supported and important results secured.

AEROLOGICAL INVESTIGATIONS.

Free-air observations by means of kites were obtained throughout the year at Drexel, Nebr., and Ellendale, N. Dak. Installation of equipment was completed for similar work at Broken Arrow, Okla., Groesbeck, Tex., Leesburg, Ga., and Royal Center, Ind. Regular observations were begun at those stations before January 1, 1919. These observations, as well as those at Drexel and Ellendale, include daily kite flights and, whenever possible, continuous series of flights covering periods of 24 to 36 hours. The records have been reduced at the central office, and the results published in aerological supplements of the Monthly Weather Review. Moreover, brief summaries are telegraphed daily to the central office and other district forecast centers.

The pilot-balloon work that was organized and conducted during the war by the meteorological section of the Signal Corps at Broken Arrow, Okla., Ellendale, N. Dak., Groesbeck, Tex., Leesburg, Ga., Royal Center, Ind., and Washington, D. C., was transferred to the

Weather Bureau during the latter half of the year. Similar work has been organized at regular Weather Bureau stations at Ithaca, N. Y., Lansing, Mich., and Madison, Wis. Observations are made twice daily, and the indicated wind conditions at various heights are telegraphed to the central office for use in furnishing advices to the military, naval, and postal aviation services. The Weather Bureau observations are supplemented by similar reports from several military and naval air stations where work with pilot balloons is regularly conducted. All of the free-air records thus obtained are furnished to the central office for final reduction and study.

Both during and after the war there was close cooperation with the Army and Navy meteorological services. Special data were furnished also to the ordnance departments and to the military intelligence and aviation services. Advices were given to the United States Navy in connection with its trans-Atlantic flight project, further details of which are stated under the section on forecast service.

TELEGRAPH SERVICE.

The prompt collection and dissemination of weather reports and warnings require an extensive network and use of commercial telegraphic facilities. Various elements of a disturbing nature contributed generally, and in some phases in an aggravated form, to a continuance of the difficulties experienced during the preceding year in maintaining the telegraphic circuits at a high standard of efficiency, although some improvement was noted during the last half of the year. Chief among the causes were shortage of experienced operators in the commercial companies, necessary employment of untrained forces, substitution of machine for manual transmission of telegrams over trunk lines, the epidemic of influenza, abridgment of the hours of labor, late opening of telegraph offices at numerous small but important points, preventing dispatch of observations at usual times, and, latterly, the prevalence of minor strike conditions.

Effectual means were promptly taken by the commercial companies as a rule, however, to remedy unsatisfactory conditions upon presentation of complaints, and, on the whole, the telegraph service was performed as efficiently as could have been expected.

Changes in telephonic rates, effective January 21, and in telegraphic rates, effective April 1, imposed additional difficulties in examination and passage of accounts for service, necessitating a large volume of correspondence to effect proper adjustment.

A complete revision of forms showing distribution of forecast messages throughout the country, approximately 1,100 daily, was accomplished, resulting in much improved record lists.

During May and June a large number of telegrams was handled in connection with the trans-Atlantic flights in which the Weather Bureau cooperated with the Navy Department, additional telegraphic loops having been installed for the purpose. As this business was filed during the rush hours of the morning and evening, its handling, coupled with the other routine work, taxed the operating facilities to the utmost.

The services of another clerk-operator are much needed to properly handle the telegraphic and auditing work throughout the crop and

hurricane seasons, and the need is much accentuated at times of increased work similar to the above. Should there be further increases of telegraphic work consequent upon the contemplated extensive cooperation with the Army and Navy, a corresponding enlargement of the telegraphic force will become imperative.

WEATHER BUREAU TELEGRAPH AND TELEPHONE LINES.

These lines have been maintained and operated generally in a satisfactory manner, considerable necessary reconstruction work having been accomplished on several. The Navy Department, the War Department, and the Coast Guard have made increasing use of them, the Coast Guard Service having cooperated largely in cable repair and other work.

BLOCK ISLAND-NARRAGANSETT PIER SECTION.

[Telegraph.]

Closing of the Weather Bureau office at Narragansett Pier on July 31, 1918, necessitated other land terminal arrangements. To meet this situation the cable was permanently connected in the office of the Providence Telephone Co. at Narragansett Pier with the Western Union wire running to Boston, thus affording a satisfactory channel of communication between Block Island and the mainland. Large use is made of this cable by the naval base on Block Island, which enjoys direct wire connection.

One mile of new three-conductor cable, costing \$2,312.64, was bought during the spring to replace a defective portion which had interfered seriously for most of the year with transmission through two of the conductors used by the Providence Telephone Co. Repairs made by the Coast Guard Service produced very satisfactory results, the cable now being in first-class condition, although laid in 1903.

NORFOLK-HATTERAS SECTION.

[Telegraph.]

Extensive repairs became necessary on the southern portion of this line, due to prostration of about 10 miles of poles resulting from effects of a severe storm on August 25-26, 1918. These repairs were completed early in the summer.

The 3-mile submarine cable connecting Manteo, on Roanoke Island, with the mainland became so defective as to seriously impair its further use for telegraph purposes. To insure continued communication with this isolated but important point 4 miles of new four-conductor cable were purchased, nearly 3 miles of which were successfully laid in June, the remainder being stored for emergency use. Two sections of land line necessary to connect the cable with the office at Manteo and the main line were rebuilt.

Four important naval stations which transact a large volume of business enjoy direct connection with the main line through to the naval base at Norfolk. Extensive use is made of the facilities of the Weather Bureau office at Cape Henry by the Navy and the Coast Guard Service, the latter effectively cooperating in the maintenance of the line. Two telephone lines belonging to that service are carried on the Weather Bureau poles between Virginia Beach and Hatteras.

KEY WEST-SAND KEY.

[Telephone.]

Nine miles of submarine cable connects these two stations. This cable was laid in 1903, and in the early part of the year became so defective as to call for a new cable to protect the naval interests in the gulf which had assumed great importance on account of war conditions. As the Sand Key station had been taken over by the Navy Department during the period of the war, a new 4-conductor cable was purchased and laid by that department.

ALPENA-THUNDER BAY-MIDDLE ISLAND SECTION.

[Telephone.]

During the year communication was interrupted 23 hours on these two lines owing to damage by thunderstorms. The poles are beginning to fail from age and will doubtless need renewing soon.

WHITEFISH POINT-GRAND MARAIS SECTION.

[Telephone.]

NORTH AND SOUTH MANITOU ISLAND-SLEEPING BEAR POINT SECTION.

[Telephone.]

BEAVER ISLAND-CHARLEVOIX SECTION.

[Telephone.]

These three lines worked continuously and smoothly throughout the year.

SAN FRANCISCO-POINT REYES (CALIF.) SECTION.

[Telephone.]

For several years past much difficulty has been experienced in communicating between these points. Arrangements were made during the winter with the Coast Guard Service for reconstruction of the line, which provided for a metallic circuit from Point Reyes to San Anselmo, where the Weather Bureau wire now terminates in an exchange, thence operated to San Francisco at established rates. The former method of communication involved rental of a wire from San Francisco to Mill Valley which connected at that point with the Weather Bureau single-grounded wire running to Point Reyes. Communication with the Mount Tamalpais station had been carried on by the use of a loop on the main line. This portion of the line now terminates in the Mill Valley exchange where connection is made with either Point Reyes or San Francisco. Approximately two-thirds of the cost of the reconstruction work was borne by the Coast Guard, and the remaining third by the Weather Bureau. Annual cost of service between the new and old systems differs but little. The new system was placed in operation on March 5, with satisfactory results. A portion of the line will need renewing with copper wire before long. Three test stations were installed on the line, which are found valuable in locating trouble.

NORTH HEAD-PORTLAND SECTION.

[Telegraph.]

Fairly satisfactory and continuous communication was maintained between these two points through the successive use of several con-

ductors in the Army cable connecting Fort Stevens and Fort Canby on opposite sides of the Columbia River. Serious and unlooked-for difficulties were encountered in putting into effect the project of purchasing and laying a new cable from funds authorized by Congress for cable and line repairs. Prolonged but unsuccessful efforts were made to determine a proper route to connect with existing land-line facilities. Utilization of the route of the abandoned cable was highly inadvisable. The selection of a new and longer route entailed construction of new land lines or unsatisfactory cooperation with other services in the use of present system. The greatly increased expense of cable and aerial material was prohibitive in view of the small amount of funds remaining after expenditures necessarily incurred in emergency repairs on the lines above mentioned. As continued use of the Army cable is permissible as long as a conductor can be spared, consummation of the project of a new cable has been deferred pending future action by the Congress.

TATOOSH ISLAND-PORT ANGELES SECTION.

[Telegraph.]

A large amount of reconstruction work was accomplished during the year. This was made highly desirable, and in places necessary, by the extensive logging operations along the route of line, railroad construction work, private road building, activities of the Spruce Production Division of the Signal Corps, and heavy storms.

The Weather Bureau station at Pysht was closed on August 31 and the repair work formerly done by the official divided between the stations on either side.

A temporary office was opened at the military camp at Joyce, Wash., August 29, and a large volume of telegraph business was carried over the line in connection with the spruce production operations at that point. The office was closed on December 25. During these four months approximately 3,100 commercial messages were handled at this station.

WORK IN CLIMATOLOGY.

No important changes occurred during the year in the work in climatology, and the several important lines were carried forward as usual, despite many general enlargements in most of the items making up the duties and some decrease in the clerical force available.

All material prepared for the several publications of the Bureau was submitted as per schedule and the final reports printed at the time designated. The weather data for the Monthly Weather Review, Annual Report of the Chief of Bureau, and the monthly and annual climatological reports for the several States were subjected to the usual careful scrutiny, and effort has been made to maintain the standard of accuracy heretofore required, although, as stated above, there has been a steadily increasing number of reports to be examined and a constant diminution of the effective working capacity of the clerical force.

COOPERATIVE REPORTS.

The work of the cooperative observers of the Bureau has been maintained in a highly satisfactory manner despite the additional duties imposed on the observing force by the unsettled world conditions and

the lessened opportunities for such work in view of the shortage of labor in general.

More changes in the observing force were necessary than usual, owing to a large shifting from the usual lines of work to those pertaining to the war, but the continuity of the work was usually provided for and the records as a whole were remarkably complete, and continued improvement in practically all features of the work was noted.

INSPECTION OF STATIONS.

The policy of inspecting cooperative stations once in each three years, temporarily suspended during the early portion of the fiscal year just closed, was vigorously taken up toward the latter part and is being continued whenever feasible for officials to absent themselves from their stations. These visits of inspection impress the cooperative observers with an added sense of the importance of their work, establish a spirit of sympathetic cooperation, and encourage them to renewed effort in case they have become discouraged at the prospective amount of work without financial remuneration or an apparent lack of appreciation by the Bureau or the public of the value of the records they are at such pains to make.

During the year most cordial cooperation was maintained with other Government bureaus in collecting meteorological reports from points that would naturally be without representation but for the willingness of the officials to take up this special duty in addition to their regular lines of work.

OCEAN METEOROLOGY.

As was pointed out in previous reports, the work of the marine section was seriously interfered with by the war, the loss of reporting vessels and censorship restrictions together having the effect of greatly reducing the number of reports available for charting and study. So far as possible, however, the work of the section proceeds along the usual lines.

Upon the close of the war attention was centered upon a program for the restoration and extension of the marine work, and plans have been formulated which will result in a material advancement of our knowledge respecting meteorological conditions of the great ocean areas.

Progress in this direction is necessary to enable the Bureau to meet the increasing demands for information regarding weather conditions over the oceans resulting from the expansion of our merchant marine and commercial development associated therewith, as well as those arising from experiments in trans-oceanic flight.

MISCELLANEOUS ITEMS OF WORK.

The usual work incident to the receipt, examination and filing of the meteorological reports of the Bureau went forward as usual. The section publications were assembled and prepared for distribution and the sets of these intended for station files for the year 1918 were bound and distributed. The binding of the original records of the preceding year was accomplished as usual and all reports put in shape for permanent preservation. The tabular matter usually extracted from the original records has been entered in the books pre-

pared for such data and all are as nearly up to date as it is practicable to keep them.

Many data on the temperatures of the country have been accumulated during the year, particularly with regard to the maximum and minimum values. Extensive compilations of the daily and weekly means of these factors for the 40-year period ending with 1918, have been obtained from the various stations. It is hoped opportunity will be afforded during the present year to properly analyze and interpret these data and present them to the public.

Near the close of the year steps were taken to present to the public in general, but particularly for the benefit of the engineering professions, through the press, more information on the daily state of the moisture in the atmosphere, and at this writing these data are being published for the three principal observations in practically all the leading papers in the country. At the same time a revision of the local station forms intended for public distribution was being considered by which similar data will be presented to the public in much greater detail than heretofore.

The extensive utilization of our accumulated records by nearly every class of our population has continued during the year, and the fact that practically every request for information has been promptly and fully met indicates the extensive character of the data we are collecting. The reputation of the Bureau for prompt service has been fully maintained, as indicated by the many acknowledgments of appreciation received for early and complete responses to requests for information.

AGRICULTURAL METEOROLOGY.

The activities under this section include the supervision of special services maintained in the interests of agriculture in the principal grain, cotton, sugar, rice, alfalfa seed, cranberry, tomato, tobacco, fruit, and potato-growing districts, as well as in the great grazing districts for the benefit of those interested in stock production; all maintained for the collection and dissemination of information relative to current weather conditions throughout the country, and their resulting effects upon the development of crops and the progress of agricultural operations.

In addition to the above, studies are conducted on the influence of weather on the development of crops, and the relation of weather and climate to agricultural activities and crop yields, including the supervision and distribution of forecasts of minimum temperatures during critical periods in districts where protective methods are extensively practiced. The fruit frost-work was very successful during the year, particularly in the Northwestern States, and gratifying progress was made during the year in studies of special mathematical methods of forecasting minimum temperatures that may be injurious to fruit.

Weather is a dominant factor in the success or failure of agricultural or horticultural operations, and special effort was made during the year to apply the information collected, through the vast organization of special and cooperative services of the Weather Bureau, to the important problem of food production in its various aspects.

SPECIAL SERVICES.

Few changes were made during the year in the special crop services maintained by the Bureau and described sufficiently in the last annual report. The cotton, corn, and wheat services were improved during the year by the inauguration of a new system of making observations whereby the minimum temperatures experienced during the preceding night were reported instead of the 24-hour minimum.

A new method of issuing reports weekly, instead of daily, in the cattle region service, has proved very satisfactory, and resulted in a material reduction of expense. There is an insistent public demand for the extension of this service over some important grazing districts not yet covered, which it is hoped to meet in the near future.

Special studies were made during the year in the development of a mathematical hygrometric formula to aid in making more accurate minimum temperature forecasts.

The special forecast and warning service was extended, with good results, in connection with spraying operations in some important fruit growing districts. So far as the depleted personnel of the bureau would permit, trained officials of the Weather Bureau were detailed to special field duty in fruit districts during critical periods for the purpose of giving advice as to the best time to conduct spraying operations. It is hoped that, when more normal conditions prevail, the Bureau may be in position to enlarge and improve this branch of its activity.

Cooperation.—By request of other departments of the Government, and for the use of the recent Peace Conference at Paris, the Weather Bureau prepared, during the fall and early winter, a general summary of the climate of Africa, with special attention to that of the former German colonies. A vast amount of climatic data was compiled, and a number of charts were prepared showing graphically the annual and monthly distribution of precipitation and temperature over the continent, together with a discussion of its climatic characteristics.

The Weather Bureau continued its cooperation with other bureaus of the department in maintaining special meteorological stations at various points in different sections of the country as an aid to research and investigation of the many agricultural problems in which weather is an important factor.

INSTRUMENTATION.

The instrumental equipment of the various stations of the Bureau has been maintained at the high standard of former years. The practical cessation of European supply and the difficulties attending American manufacture of instruments have made it less simple than heretofore to obtain suitable supplies, particularly when such supplies involved the labor of highly skilled artisans. Prices of instruments and of parts have increased greatly, and we have been able to maintain the equipment of the Bureau with the appropriation available only by working over a considerable stock of apparatus available. The instrument shop of the Bureau has been availed of to salvage instruments that under ordinary conditions would hardly be worth repair. Naturally a time will soon come when further opera-

tions of this character will not be possible, and, unless prices recede, a substantial increase in the allotment for instrumental equipment must follow.

STORM-WARNING EQUIPMENT.

The three-lantern system was completed on the Atlantic coast during the fall of 1918, and work on the Pacific coast was about half completed at the end of the fiscal year. The entire installation will be finished by October 1, 1919. It is a pleasure to report that there has been very little expense for repairs at stations equipped with this new system, and while the initial expenditure of making the change is somewhat high, it is believed that the total cost to the Bureau through a period of, say, 10 years will be no greater than would be the cost of maintaining the former less effective equipment.

NEW INSTRUMENTS.

A form of thermograph, intermediate in size between our present long- and short-range instruments, has been adopted as standard for future purchases and will eventually replace all thermographs now in use in the Bureau.

A minimum thermometer of larger index, so as to obtain increased visibility and thereby retain to the Bureau the services of cooperative observers who must now give up the work because of failing eyesight, has been worked out with the cooperation of the manufacturers, and it is hoped to obtain a quantity of these in the near future.

A nephoscope of rugged construction and simple form has been designed for general use in the Bureau, and a contract for 100 of these has been awarded.

EVAPORATION WORK.

Extensions of the Class A evaporation stations have been made only where satisfactory and continuous observations were to be expected. Thirty-eight stations well distributed over the country now render regular reports.

PRINTING AND PUBLICATIONS.

War conditions at the beginning of the year continued to embarrass the work of this division through the loss of employees and the impossibility of replacing them with efficient substitutes. Thus the lack of skilled press feeders necessitated keeping idle some of our presses much of the time and compelled us to use some of our scant printing allotment for having work done at the Government Printing Office that would otherwise have been taken care of by own own printing plant. However, no delays or interruptions were allowed to occur in printing and distributing the daily weather maps, weekly crop bulletins, and other periodical publications of the Bureau, whose value depends entirely upon the promptness and regularity with which they are placed before the public. Since the close of the war conditions have gradually become more satisfactory, and the early installation of automatic press-feeding machines will prevent a recurrence of some of the troubles experienced during the past year.

The demand for Weather Bureau publications relating to meteorological and allied subjects maintained its usual high level, especially as regards requests received from military and naval sources for

meteorological data in the aid of aeronautics and ballistics. Public schools and other educational institutions also showed continued interest in the work and publications of the Weather Bureau.

At the end of the year there were 546 paying subscribers to our various periodical publications, exclusive of the Monthly Weather Review, and the total receipts from that source amounted to \$697.17. An additional amount of \$117.90 was received from the sale of blank weather maps for school use. Subscriptions for the Monthly Weather Review are received and filled by the Superintendent of Documents, Government Printing Office, who requires 125 copies each month for that purpose.

To guard against an improper use of information regarding crop conditions in advance of the time set for its release to the public, all copy for the National Weather and Crop Bulletin is now set up by our printers in a locked room of the Division of Agricultural Meteorology, and the advance sheets are printed on a proof press in the same room for distribution to the press and telegraph companies at the appointed hour.

The principal publications issued during the year included the Monthly Weather Review and Supplements; Daily River Stages for 1917; Climatological Data for the United States, by Sections; Instructions to Cooperative Observers; Daily Washington Weather Map; National Weather and Crop Bulletin; Snow and Ice Bulletin; Forecast cards, daily except Sundays and holidays; Weekly Forecasts; and Monthly Meteorological Summary for District of Columbia.

Some of the more important features of the publications of the past year are mentioned in the following:

Station annual summaries with comparative data forming very full local histories of the weather have continued to be published at the larger stations, and some heretofore without such summaries have been enabled to have them printed through courteous cooperation with officials at stations having printing facilities. These local climatic histories have a wide circulation and afford convenient means for the distribution of important information needed by the public.

The snow and ice bulletins were issued as usual, and some improvements were possible in the extent of the information heretofore obtainable in the remote mountain sections of the West, by the hearty cooperation of the Forest Service, and other agencies of the Government whose officials are required to make occasional visits in the high mountain districts forming the headwaters of important streams that supply the great irrigation systems. Reports on the snowfall during the past winter showed at the close a marked deficiency in the usual supply of well-packed snow over several important drainage systems. Later advices show a serious shortage of irrigation water in these regions, and much loss to crops in areas dependent thereon is reported. These bulletins have a large circulation and are in constant demand, particularly by the irrigation interests.

Several reprints of the sections of Bulletin W, "Climatology of the United States by Sections," were provided for during the year. The editions of many other sections are rapidly becoming exhausted, and it is hoped that practically the entire set can be brought down to date, more important data included, and all reprinted in the near future.

These publications afford a most satisfactory means of giving to the public important information of climatic conditions in all parts of the country and are invaluable in the work of this Bureau, which consists so largely in supplying weather information to all classes of individuals.

A rather full history of the cold winter of 1917-18, with a liberal display of charts showing some of the more important features of the pressure distribution and the resultant wind, temperature, and snow-fall conditions over the North American Continent and the adjacent waters, as far as observations would permit, was issued during the year and given a wide distribution through the *Monthly Weather Review*.

Weather and Crop Bulletin.—The National Weather and Crop Bulletin was issued as in previous years without material change in policy. In addition to current weather and crop information, the bulletin contains, from time to time, charts and discussions bearing on the relation of climate to crops and agricultural operations. The value of this publication is evidenced by the popular demand for it, which has grown to such proportions as to severely tax the printing facilities of the Bureau in its issue.

During the active agricultural season a weather and crop summary is published at each section center, 42 in number, which is disseminated by bulletins and through the public press.

Pacific coast weather and crop service.—A special weather and crop service, covering seven of the far Western States, was continued during the year, with San Francisco as the district center. The bulletin issued at that point conforms in both scope and time of issue to the National Weather and Crop Bulletin and has proved of great value.

Monthly Weather Review.—Contributions to the *Monthly Weather Review* increased rapidly after the signing of the armistice, which liberated much material previously held as confidential and also allowed former contributors to turn from their war-time activities.

Beginning with the January, 1919, issue, the make-up of the *Monthly Weather Review* was consolidated by dividing the contents into two groups—Contributions and Bibliography and Weather of the Month—and some improvement was made in the attractiveness. The contents of the weather section were rearranged and some new features added, the most important being the current weather of the Atlantic and Pacific Oceans instead of that for the corresponding month a year before.

LIBRARY.

During the year 890 books and pamphlets were added to the library, bringing the total strength of the collection up to about 38,000. A considerable amount of bibliographic work has been done during the year, including the preparation of a nearly exhaustive bibliography on the climatology of South America. A new edition of the publication "Brief List of Meteorological Textbooks and Reference Books" has been prepared for the printer. Several of the more important foreign periodicals, whose receipt was interrupted during the war, are now being received and have been indexed to date.

INVESTIGATIONS IN SOLAR RADIATION.

The necessity of employing untrained observers led to the suspension of radiation measurements at Santa Fe, N. Mex., between September 12, 1918, and April 23, 1919, and to a marked reduction in the number of measurements at Lincoln, Nebr., during July and August, 1918. By the end of April, 1919, measurements were being obtained as heretofore at both these stations, and also at Madison, Wis., and Washington, D. C.

The assignment of the official in charge of solar-radiation investigations to the editorship of the *Monthly Weather Review* greatly curtailed his opportunity for research work. However, apparatus was tested and an observer trained in its use for the measurement of nocturnal radiation in orchards at Pomona, Calif., and at Medford, Oreg., in connection with the frost-protection investigations of the Weather Bureau. Measurements were also made of the rate at which heat is radiated from different types of oil heaters employed in orchard heating.

At the end of the fiscal year the work of computing from the radiation measurements available the diurnal and annual variations in radiation intensity with geographical position in the United States, and those which depend principally upon latitude, altitude, and the vapor content of the atmosphere, was well advanced. One of the by-products of the computation has been the determination of the relation between radiation intensity, expressed as a percentage of clear-sky intensity, and the percentage of cloudiness and of the possible hours of sunshine, as observed by eye and recorded automatically, respectively, at most Weather Bureau stations. The results of the computation, which will be shown graphically, will soon be ready for publication.

From the relation between the sun's total, or heat radiation, and the luminous solar radiation, heretofore determined, charts and tables are also being prepared showing the intensity of direct solar illumination on a surface normal to the solar rays, on a horizontal surface, and on vertical surfaces in the plane of the meridian and the prime vertical, respectively, and also the intensity of diffuse sky illumination on a horizontal surface. The illumination data are furnished in response to repeated and urgent requests from illuminating engineers and architects, and must be considered preliminary in their character, as the investigation has disclosed the need of extensions in the observational work, especially on the Pacific and Gulf coasts and in the northern tier of States.

INVESTIGATIONS IN SEISMOLOGY.

The important work of collecting and publishing earthquake data, begun December 1, 1914, has been continued during the year. These data are of two kinds, noninstrumental reports of earthquakes felt and instrumental records, often of quakes imperceptible to the senses and even originating at a great distance. The noninstrumental reports are rendered by all the regular stations of the Bureau, nearly 200 in number, and also by nearly all the Bureau's 4,500 cooperative observers. The instrumental records published by the Bureau have been obtained in part by instruments owned and operated by the

Bureau itself, one at Washington, D. C.; one at Northfield, Vt.; and one at Chicago, Ill., and partly through the cooperation of a number of additional stations distributed from Panama to Alaska and from the Hawaiian Islands to Porto Rico.

During the calendar year 1918, 127 separate earthquakes strong enough to be felt were reported from different parts of the continental United States. The great majority of these did no damage whatever; a few, however, were strong to severe. One of these, occurring on April 21, destroyed the business sections of Hemet and San Jacinto, in southern California. An equally severe quake occurred on May 28 in New Mexico, but did very little damage.

The chief earthquake damage in our outlying possessions occurred in Porto Rico on October 11 and 12. The records of this series of quakes obtained at Washington and Chicago were used by the commission especially delegated to study these disturbances.

In addition to the above regular work certain studies of meteorological phenomena have been made and several brief papers published.

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., September 29, 1919.

SIR: I have the honor to transmit herewith a report of the operations of the Bureau of Animal Industry for the fiscal year ended June 30, 1919.

Respectfully,

JOHN R. MOHLER,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

ACTIVITIES RECEIVING SPECIAL ATTENTION.

INFORMATION ON FOREIGN LIVE-STOCK CONDITIONS.

To aid the live-stock industry in meeting changed international conditions following the armistice, the Bureau of Animal Industry has given close attention to a number of special problems. An animal-production committee was formed to make a thorough study of meat animals and necessary plans whereby American farmers could supply the quantities of meat food products required. This work is being continued. To obtain accurate information on current live-stock conditions abroad, three representatives of the bureau visited Europe at different times during the year. Their observations in five countries were published through the news channels of the department.

The bureau has also issued statements through addresses and the press, outlining the position of the United States in relation to the world at large with respect to supplies of cattle, sheep, and swine. In addition, a circular, "The Trend of the Dairy Cattle Industry in the United States and Other Countries," was published. This shows by simple charts the advance or decline of cattle raising in the principal countries of the world from 1850 to 1918. This publication was followed by two others of similar character, one dealing with the butter and the other with the cheese industry.

LIVE-STOCK EXPORT REGULATIONS REVISED.

During the fiscal year the bureau, which issues export certificates for live stock, adapted its regulations to meet changed conditions. In their new form they facilitate materially the safe and humane handling of domestic animals, especially dairy cows and breeding cattle carried on ocean steamers.

By contributing to the arrival of the stock in the best possible condition, the revised regulations are a factor leading to a continuance of our export trade in live stock. During the year numerous shipments of both cattle and swine were made to South American points under export certificates issued by the bureau.

PROGRESS IN DISEASE CONTROL.

The long and anxious campaign which the bureau has been waging against animal diseases brought encouraging results during the last year. From a scientific point of view, victory over most of these maladies is in sight, and in a number of cases eradication is nearly complete. (See accompanying charts.)

Cattle scabies, which in 1906 was prevalent in nearly one-half of the United States, now appears only as outbreaks in limited areas. These outbreaks are being suppressed.

Eradication of sheep scabies, which in 1906 existed in more than one-half of the land area of the country, is now about nine-tenths complete.

The cattle tick which causes Texas fever has had its domain reduced from more than 700,000 square miles in 1906 to less than 300,000 square miles in 1918. Progress has been continuous year after year.

Hog cholera presents a somewhat different problem, as the nature of the disease makes the campaign of a sporadic character. But the use of antihog-cholera serum, especially in connection with virus, is a definite means of preventing serious outbreaks.

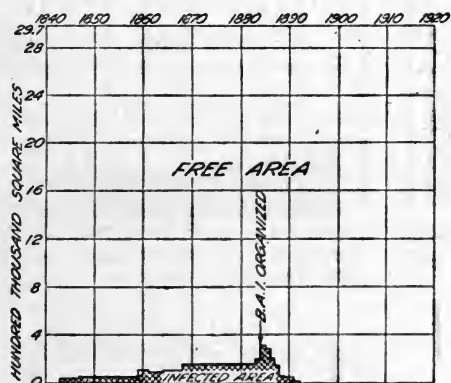
Recent investigations have shown that the common intestinal roundworm of the pig is not only injurious as an intestinal parasite but that during an early stage of its development, while still microscopic in size, it invades the lungs and may give rise to serious troubles. Furthermore, pigs that survive this invasion of the lungs may never fully recover, but fail to grow properly, and become unprofitable runts. It is believed that much of the damage caused by the intestinal roundworm can be avoided by simple sanitary precautions, the practical application of which is now being tested. The problem of so called "mixed infection" is also under investigation, with the view of determining more definitely its relation to hog cholera and the proper measures of control.

The United States has remained free from foot-and-mouth disease, and the bureau continues to exercise vigilance against its possible introduction. Serious outbreaks in foreign countries have been closely studied, and bureau inspectors have given special attention to cargoes of live-stock products from such countries, importations of the animals themselves not being permitted.

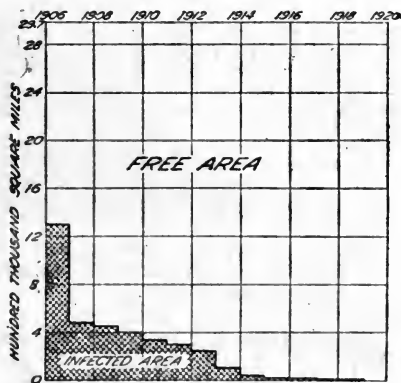
A questionnaire inquiry made among stockmen and State officials indicates an almost universal support of the method which the bureau employed successfully in stamping out past outbreaks of foot-and-mouth disease by slaughter of the animals affected.

Eradication of tuberculosis has progressed as fast as the work could be handled by the veterinary force employed; in fact, there has been a waiting list of herds to be tested. Under present authority from Congress only one-third of the appropriation for tuberculosis-

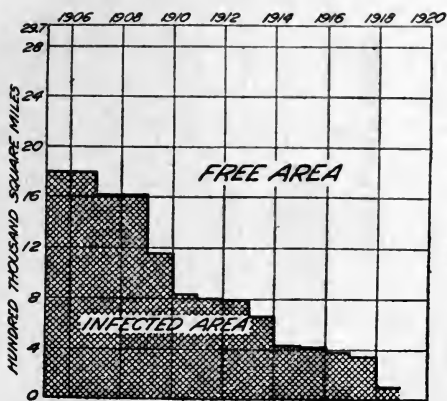
CHARTS SHOWING PROGRESS IN ERADICATING CONTAGIOUS ANIMAL DISEASES.



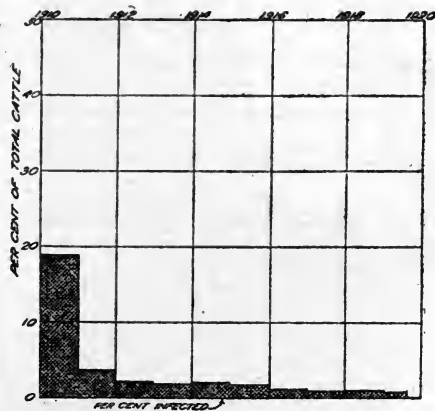
Contagious pleuropneumonia. Eradication begun in 1884, completed in 1893.



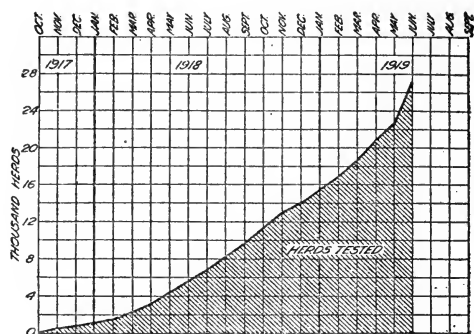
Cattle scabies. Nearly one-half of the United States affected in 1906; eradication nearly completed in 1919.



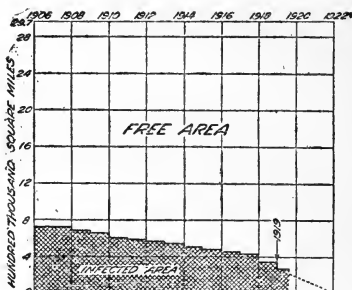
Sheep scabies. Eradication more than nine-tenths complete.



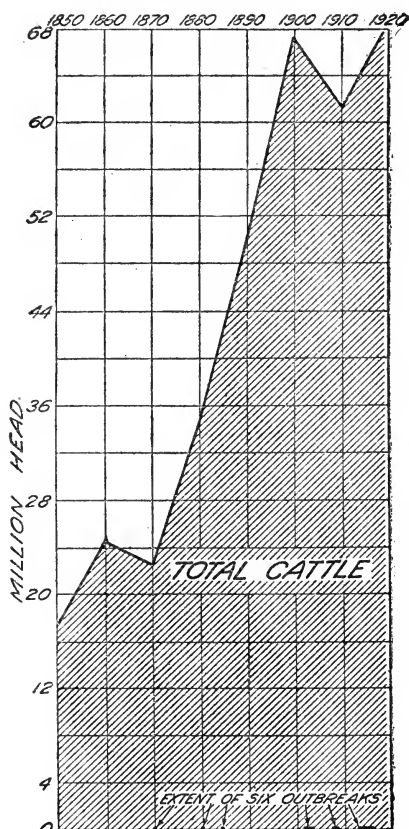
Eradication of bovine tuberculosis in District of Columbia.



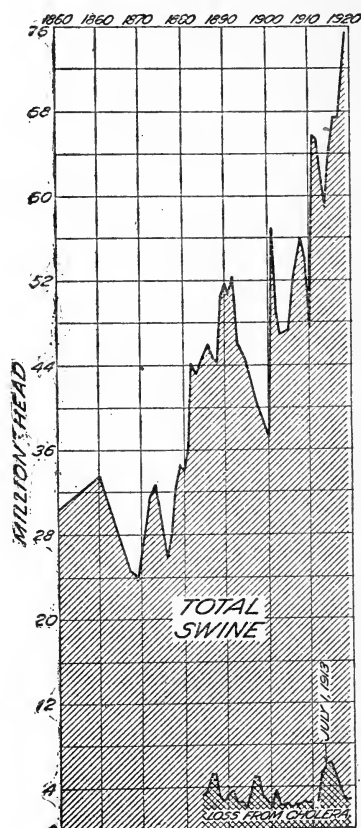
Extent of cooperative tuberculosis eradication work in the United States, showing herds under supervision.



Eradication of cattle ticks from the United States. Every year since 1906 has shown progress.



Outbreaks of foot-and-mouth disease in cattle. In 1870, 1880, and 1884 only a few head were infected; in 1902, 4,712 were infected; in 1908-9 2,025; and in 1914-1916, 77,240 were slaughtered. The disease is now absent from the United States.



Extent of hog-cholera losses. Immunization by serum prevents recurrence of serious outbreaks of the past.

eradication work can be used for operating expenses, the remaining two-thirds being allotted for the payment of indemnities. A reversal of the ratio, making available two-thirds for operating expenses, would increase greatly the progress of the work. Necessarily the diseased animals must be found before indemnity can be paid, and when only a few animals in a large herd react to the test the operating expenses exceed the Federal share of indemnity. Yet, finding those few reactors promptly before the disease spreads is essential to maintain the herd in a healthy condition.

The bureau now conducts tuberculosis-eradication work cooperatively with the officials of 43 States, and negotiations are in progress to extend the work to others. The District of Columbia is an excellent example showing that the disease is vulnerable to a definite campaign of eradication. In 1907 tuberculin testing in the District was undertaken, and more than 18 per cent of the cattle were found to be tuberculous. Tests made in 1919 on all cattle in the District showed a percentage of only 0.63 of 1 per cent affected. This is lower than in any previous year, and the disposal of the last reactors makes the District practically a tuberculosis-free area.

SECOND ACCREDITED LIST ISSUED.

During the year the bureau issued Herd List No. 2 of cattle officially accredited as free from tuberculosis and containing also a list of herds that successfully passed one test with a view to certification. Compared with list No. 1, dated July 1, 1918, the second list shows noteworthy progress as follows:

Accredited-herd list summary.

List.	Cattle accredited.	Cattle once tested without reactors.
List No. 1, July 1, 1918.....	6,915	22,212
List No. 2, April 1, 1919.....	19,021	97,243

From April 1 to the end of the fiscal year further progress was made, and the work is receiving hearty support from live-stock owners and officials.

CONSTRUCTIVE SIDE OF REGULATORY WORK.

Disease eradication is the basis of ample production and in final analysis of liberal consumption and proper nutrition. If the live-stock men of the country had to contend with pleuropneumonia, foot-and-mouth disease, surra, rinderpest, and other animal scourges on top of their present problems, production certainly would fall and consumption would be curtailed by reason of high prices necessary to cover the risks of production. Fortunately, this list of diseases may be considered a problem already solved. They do not exist in this country and the bureau is on the alert to keep them out.

The bureau has also taken energetic steps to check attempts at shipping diseased stock interstate, and perfected and strengthened its regulations especially with regard to bovine tuberculosis.

Coupled with those efforts, and to acquaint stockmen with the constructive side of the work, it has pointed out at frequent intervals the purpose of the regulations. As a result closer cooperation is developing between the public and the bureau's inspectors and veterinarians—a condition helpful to the effectiveness of field work.

MEAT INSPECTION RENDERS LARGE SERVICE.

The Meat Inspection Division set a new high mark in the extent of its service to the public. During the year more than 70,000,000 animals were slaughtered under Federal inspection, an increase of about one-fifth over last year, and also over the average of the last 12 years. Besides the bureau completed a survey of municipal and State meat inspection, and is prepared to aid cities in inaugurating or improving local supervision over their meat supplies.

IMPROVEMENT IN QUALITY OF LIVE STOCK.

From records collected it appears that the per capita meat consumption in the United States is increasing. This condition and the increase in population of the country point to the need for closely studying methods of production, especially with a view of making them as economical and attractive as possible. A similar problem exists regarding dairy and poultry products.

To establish and disseminate information on sound principles of production the year's work included numerous experiments in feeding, breeding, and care of stock. An extensive breeding experiment with dairy cows has been undertaken cooperatively with two States. Results of many years of cow-testing work in all parts of the country were compiled, condensed, and prepared for publication. Poultry culling as a practical means of improving the average egg production has received special attention.

In all classes of live stock the value of purebred sires of good type has become so evident that a special campaign has been undertaken to place the facts before the public and enlist efforts to use purebred sires. In cooperation with the various agricultural colleges, live-stock associations and similar organizations, the bureau formulated plans for the work applicable to all parts of the country, and the campaign was inaugurated, effective October 1, 1919, under the slogan "Better Sires—Better Stock." Briefly, it provides (1) official recognition for live-stock breeders using purebred sires in all classes of stock; (2) a means of recording prominent breeds and varieties in States and counties; and (3) printed information on successful breeding methods suitable to average farm conditions. Every live-stock owner is eligible to enrollment in the campaign, the purpose of which is to banish scrub and inferior sires from the United States.

LITERATURE.

During the year 83 new publications were issued or contributed by the bureau. These include 15 Farmers' Bulletins, 10 Department Bulletins, 8 contributions to the Department Yearbook, 12 issues of

Service and Regulatory Announcements, 8 articles for the Journal of Agricultural Research, 22 miscellaneous pamphlets, and 8 orders in the nature of regulations. In addition 247 articles relating to the work of the bureau were published in the Weekly News Letter.

REPORTS BY DIVISIONS.

The year's work as conducted by the various divisions of the bureau is presented more fully in the following pages:

ANIMAL HUSBANDRY DIVISION.

The war work of the Animal Husbandry Division, under George M. Rommel, chief, fell under two main heads—the emergency movement of drought-stricken live stock and the campaigns to stimulate production of hogs, poultry, beef cattle, and sheep. The conservation feature was quite as strongly emphasized as the importance of actual increase in production.

SAVING DROUGHT-STRICKEN CATTLE.

The shipment of cattle from drought-stricken areas was aided in the summer of 1918 as in the preceding year. The movement was principally from Texas to the Southeastern States, and nearly 300,000 head were shipped. The cattle were mostly cows, and a large proportion were bought outright in small lots and went into a section which promises to be our next great area for expansion in beef production. Where they were properly cared for they gave farmers a start of from 5 to 10 years over the usual methods of grading up native stock by purebred bulls. It cost the Government only a few cents a head to move these cattle. If these well-bred cattle had not been moved as they were, they would have perished on the ranges or would have been slaughtered at the market centers.

In the summer of 1919 a similar movement of wide scope was undertaken to meet a similar situation in Montana and adjoining States. The work is in charge of a committee representing the Bureau of Animal Industry, the Bureau of Markets, and the States Relations Service, in cooperation with the agricultural colleges and the United States Railroad Administration.

STUDIES OF ANIMAL PRODUCTION.

The committee formed in the Animal Husbandry Division to study meat-animal production throughout the world as a war-time measure has continued its work. In the statistical part of its researches it had the hearty cooperation of the Bureau of Crop Estimates. The purpose was to prepare a program for animal production in 1919 which would meet the demands of the Allies and be practicable of application by our farmers. The essence of the committee's report was adopted in the department's recommendations published in the fall of 1918. The committee has devoted some study to the same subject for 1920, and it is the intention to continue this study of world meat production annually so far as resources permit.

BEEF-CATTLE INVESTIGATIONS.

BEEF PRODUCTION.

The beef-cattle experimental work was continued in Mississippi, North Carolina, and West Virginia, in cooperation with the State agricultural colleges, and on the Animal Husbandry farm at Beltsville, Md. In the steer-fattening experiments rations with only a small amount of concentrates were used. Nitrogenous supplements were used liberally, but the amount of grain was reduced to a minimum. Limited grain rations were used with satisfactory results, which indicates that beef can be produced economically largely on roughage when supplemented with a protein-rich feed.

On the farm at Beltsville, Md., four lots of 2-year-old steers were fed to compare cottonseed meal and soaked velvet beans when used with and without the addition of shelled corn. The addition of corn to a ration composed of corn silage, cottonseed meal, and wheat straw did not pay. The addition of corn to the ration of velvet beans and corn silage was profitable. The lot receiving corn silage and soaked velvet beans with a small quantity of cottonseed meal as an appetizer produced the most economical gains and showed the greatest profit, even though the daily gains and the selling price of the cattle were lower than those of any of the other lots.

In the baby-beef production experiments at Lewisburg, W. Va., 22 calves, after being weaned in the fall of 1918, were started on feed December 12 and received a ration of corn silage, clover hay, shelled corn, ground oats, wheat bran, and cottonseed meal. They were turned out to grass April 25 and were fed supplemental feeds on pasture in the summer, with the intention of marketing them as finished baby beefs in the fall or early winter of 1919.

At Canton, Miss., two lots of calves averaging 392 pounds were fed for 112 days to determine which is the better ration, corn silage and cottonseed meal or corn silage and cottonseed meal supplemented with chopped corn. The addition of chopped corn did not greatly increase the daily gains but greatly increased the cost of gain.

WINTERING STEERS.—At Springdale, N. C., and Lewisburg, W. Va., several lots of steers were wintered to determine the relative merits of wintering on different rations and to prepare for grazing experiments the following summer.

At Springdale five lots of steers received the following rations: (1) Mixed hay, (2) corn silage, (3) corn silage and corn stover, (4) winter pasture with additional feed during the few stormy days, (5) corn stover, mixed hay, wheat straw, and ear corn. The results showed that so far as condition of the cattle was concerned there was practically no difference in the five lots, the principal difference being in the cost of the rations.

At Lewisburg three lots of steer calves were wintered 134 days on the following rations: (1) Corn silage, hay, and cottonseed meal, (2) silage and clover hay, (3) mixed hay and a grain mixture consisting of parts by weight, shelled corn 3, wheat bran 1, oil meal 1. At the end of the winter the grain-fed calves were in somewhat better condition, while the calves in lot 1 were also in good condition. The steers in lot 3 were in the best condition, but the ration was extremely expensive. The first ration proved to be the most satisfactory.

SUMMER GRAZING OF STEERS.—At Lewisburg and Springdale steers were grazed on pasture to determine what effect the different methods of wintering had on gains from grass the following summer. The steers at each station had the run of about 3 acres per head. At Springdale the steers that had been fed a corn-silage and corn-stover ration made the largest gains on pasture. However, as the winter-grazed steers came through the winter in good condition and made satisfactory summer gains on pasture, the winter-grazing method must necessarily be considered satisfactory under certain conditions.

At Lewisburg the calves which had received a mixed-grain ration in addition to mixed hay gained slightly more during the summer than did the other lots, although the use of an expensive winter ration was not economical.

CATTLE BREEDING.—The 20-year breeding experiment in cooperation with the Kansas agricultural experiment station has been in progress at Manhattan since September 1, 1915. The principal objects are to determine whether the milking tendency in beef cattle is transmitted mainly by the dams through the male line of descent, and to what extent this milk-giving function of the dam influences the beef character of the progeny. The experiment has not progressed far enough to make any deductions. Several steers and bull calves have shown unusual merit and become prize winners of considerable importance.

WINTERING BREEDING COWS.—At Lewisburg, W. Va., and Canton, Miss., the experiments in wintering beef breeding cows were continued. At Lewisburg the rations were (1) corn silage, mixed hay, and wheat straw, (2) corn silage, cottonseed meal, and wheat straw, (3) corn silage, soy-bean hay, and wheat straw. There was no marked difference in the condition of the cows at the end of the winter period. The main difference was in the relative costs of the rations. The second ration was found to be the most economical and satisfactory.

At Canton 20 grade cows were given a ration of oat straw and cottonseed cake, while 20 others were grazed on velvet-bean pasture with the addition of cottonseed cake after February 16. As less labor was necessary to care for the winter-grazed cattle, this method of wintering is considered economical and satisfactory.

NEW STATIONS.—Additional investigations were begun at Jonesboro, Ark., in cooperation with the Jonesboro agricultural school and the Arkansas experiment station at Fayetteville. Thirty pure-bred cows, 10 each of Shorthorn, Hereford, and Aberdeen-Angus, were purchased during the spring of 1919. Actual experimental work did not commence until July 1, 1919.

The experimental work at Collins, Miss., was discontinued at the end of the fiscal year 1918, and a new station was established at McNeil experiment station, Miss., in cooperation with the State experiment station. Work begun at Collins will be continued at the new station.

Arrangements have been made for cooperation with a land and timber company in studying the raising of cattle in Palm Beach County, Fla., under southern ranching conditions.

BEEF-CATTLE EXTENSION.

Beef-cattle extension work was an important part of the movement to increase production. The extension specialists worked in all sections of the country, but much of the work was done in regions where the beef-cattle industry is practically new. The States included were Alabama, Arkansas, Florida, Georgia, Iowa, Mississippi, North Carolina, North Dakota, Oregon, South Carolina, Tennessee, Texas, New Mexico, and Virginia. The work was done in cooperation with the State agricultural colleges through their extension divisions, and particularly with the county agricultural agents.

The elimination of scrub bulls and replacing them with purebreds was advocated. The specialists placed a total of 1,408 purebred bulls, 1,981 purebred cows, and 11,291 grade cattle, in addition to approximately 150,000 head of cows and steers brought in from the drought area in the southwest. Many sales were conducted under the direct supervision of the beef-cattle specialists. The cattle for these sales were usually inspected and the undesirable ones eliminated. Fifty-nine live-stock breeders' associations, with a reported membership of 1,524, were organized. Numerous calf clubs were organized among the boys and girls. The specialists held 464 meetings at which they addressed 23,633 people in the interest of better live stock. They also did some useful work in demonstrating the value of pasture and in giving advice on the growing of winter feeds and the planning of winter rations.

BEEF-PRODUCTION DEMONSTRATIONS.—Three hundred and seven demonstrations of various kinds were conducted to show the most approved methods and practices in beef production, including feeding, judging, dehorning, fitting animals for shows and sales, and other subjects. Thirty-nine herdsmen's courses were given. Each specialist conducted a number of steer-fattening demonstrations. One of these, on a Georgia farm, was of special interest because the cattle had been shipped from the drought-stricken area of Texas. Ninety-two head averaging 700 pounds were fed for a period of 101 days and made an average daily gain of 2.57 pounds. They cost \$10.50 per hundredweight and sold for \$12.50 per hundredweight. With this margin there was an average profit per steer of \$16.32. The feed cost per 100 pounds of gain was \$11.31.

SWINE INVESTIGATIONS.

Twenty-three purebred sows of six breeds and four purebred boars of four breeds were bought for the Beltsville farm. Sows saved for breeding purposes from those raised on the farm increased the number of brood sows in the herd to 38.

Experiments were conducted to determine the value of soaked whole and ground velvet beans when fed to hogs. Four lots of 10 pigs each were carried from August 2 to November 5 on the following rations: (1) Shelled corn and fish meal; (2) soaked whole velvet beans and shelled corn; (3) soaked ground velvet beans; (4) soaked ground velvet beans, shelled corn, and fish meal. The results showed average daily gains in weight of 1.277, 0.586, 0.417, and 1.115 pounds, respectively, at feed costs of 13, 18.3, 23, and 14.3 cents per pound of gain.

In an experiment to determine the value of a hog wallow in the fattening pen two lots of 10 pigs each were fed exactly alike, one lot having access to a cement hog wallow. In a period of 67 days the pigs having access to the hog wallow gained an average of 18 pounds more than the others.

In two experiments to determine the effect of lice upon the fattening of pigs it was found that 0.31 and 0.53 pound more of grain was required to produce each pound of gain in weight in the lice-infested pigs than in those free from lice.

SWINE HUSBANDRY EXTENSION.

Fifty-six field men were employed in extension activities in swine production, which included pig-club work and the emergency pork-production campaign.

PIG CLUBS.—Cooperative work in connection with boys' and girls' pig clubs was conducted in 25 States, where there was an enrollment of 72,608 members, or an increase of 102 per cent over the year before. Complete reports were received from 11,593 members. The fact that the pig-club membership has doubled in the last year is only a slight indication of the zeal with which the boys and girls responded to the plea for increased meat production. A large percentage of the club members raised more than one pig, and there was a great increase in the number of sows and litters raised.

EMERGENCY PORK-PRODUCTION CAMPAIGN.—The Animal Husbandry Division undertook to aid in bringing about the production of sufficient pork and lard, with special attention to the needs of the Army and the Allies. It is only fair to say, however, that the Food Administration's influence on prices was one of the principal factors in maintaining and increasing production. Swine specialists of the Animal Husbandry Division cooperated with the State extension forces, county agents, and other agencies. In the Corn-Belt States the work was carried on as a separate enterprise, while in many of the Southern States it was associated with the pig-club work. Among the measures advocated were better feeding methods, the use of self-feeders, the growing of suitable forage crops, the improvement of quality of hogs, the production of fall as well as spring litters of pigs, the formation of breeders' associations, and the home killing and curing of pork. Demonstrations in the use of the self-feeder and of forage crops were conducted in many counties, and the farmers were brought together at the demonstration farms to see the results. There was a big increase in the number of fall litters raised in 1918. In the efforts to promote the raising of better hogs, especially in the Southern States, the swine specialists assisted the farmers in purchasing breeding stock and in selecting the best animals from their herds for breeding purposes. The home killing and curing of pork was encouraged by demonstrations and by exhibits at fairs. The Negro farmers of the South received special attention in this respect, and great improvement in the quality of meat cured by them has resulted.

MOVEMENT OF FEEDER HOGS.

Because of a shortage of feed resulting from the drought in the Southwest, a great number of light hogs weighing from 60 to 125 pounds were shipped to market at a time when they should

have been fattened. The bureau undertook to aid in having these hogs utilized as feeders, in cooperation with the Bureau of Markets, the live-stock markets, the various State extension forces, and local organizations.

Two methods were used. One was to have a representative visit the various stockyards and make arrangements to have the feeder hogs received, sorted, vaccinated, and disinfected. Then by publicity campaigns and correspondence, farmers desiring feeder hogs were informed when shipments of such animals could be expected and were invited to come and select their feeders. The other method was for the county agent to procure lists of farmers having feeder hogs for sale and send them to the State director of extension. Inquiries for feeder hogs were also sent to the extension office, and purchaser and seller were thus brought together. While definite statistics are not available, it is certain that more than 100,000 feeders were shipped into the Corn Belt as a result of this campaign.

FISHERY BY-PRODUCTS AS HOG FEED.

For several years the Animal Husbandry Division has been co-operating with the Bureau of Fisheries in studying the use of fish meal as a protein feed for swine. As a hog feed this material has been found to be equal to high-grade tankage, of which the supply is inadequate. During the year a new product known as shrimp bran was studied. The results of tests with this product as compared with fish meal, the remainder of the ration being shelled corn and middlings, were very favorable.

MEAT CURING.

The abattoir at the Beltsville farm was extensively used during the year for the study of methods of curing pork, particularly from the standpoint of home consumption on the farm. An exhibit of products cured at the Beltsville abattoir was made at the National Swine Show and at the International Live Stock Exhibition. Proceeds of sales of meat from the abattoir amounted to \$4,788.47.

FEEDING GARBAGE TO HOGS.

A representative of the division visited various parts of the country in studying methods of garbage disposal by hog feeding. The results are being prepared for publication.

SHEEP AND GOAT INVESTIGATIONS.

FARM-SHEEP INVESTIGATIONS.

Experimental work with farm flocks of sheep is carried on at the bureau's farms at Beltsville, Md., and Middlebury, Vt.

At Beltsville a study is being made of specialized intensive sheep raising with complete reliance upon forage crops for summer pasturage. In 1916 a 30-acre area did not produce sufficient forage to feed satisfactorily 44 Southdown ewes and 33 lambs. This field is now capable of furnishing sufficient summer feed for 100 ewes with their lambs. The improvement is due in part to the application

of manures, lime, and phosphates, but chiefly to the fact that leguminous crops were largely used and all crops were fed upon the ground, the unused residues being plowed in. The results show clearly the possibility of a profitable sheep-raising business upon eastern lands under a system of seeding a rotation of forage crops and allowing such frequent changes of pasture as are necessary to prevent parasitic troubles.

The Southdown ewes employed in the forage-crop experiments were divided into lots for fall breeding to allow a test of the effect of feed upon the size of the lamb crop. The experiments in 1916, 1917, and 1918 showed that the yield of lambs can be increased by flushing only when ewes are in comparatively low condition at the beginning of the breeding season. The 1918 experiment allowed a considerable difference in condition between the unflushed and grain-fed lots, which comprised 18 ewes each. The lot receiving grain produced 150 per cent of lambs, while the other lot yielded 118 per cent. Another lot of similar size that received no grain but was given sufficiently good pasturage to produce the same gain in weight as made by the grain-fed lot yielded 142 per cent of lambs.

At the Middlebury farm 130 yearling western ewes were added in the fall of 1918. Their grazing upon the pastures, which were quite weedy, was beneficial to the pastures. These ewes are being used also in the study of the relation of nutrition at mating time to the size of the lamb crop.

RANGE-SHEEP INVESTIGATIONS.

Substantial progress has been made at the Government sheep-experiment station at Dubois, Idaho, though the work is still restricted by lack of equipment. During the year a cottage for ranch employees, a combined garage, pump house, and tool house and an ice house were erected. About six miles of fencing has been put up. In the fall of 1918, 900 ewes were bred, and in June, 1919, there were on hand 840 lambs. The plan of keeping full records of lamb and wool production, as well as notes of conformation and quality of wool for each individual ewe, is being continued. The data now on hand are being prepared for publication.

GOAT INVESTIGATIONS.

The flock of milk goats at the Beltsville farm is being maintained. All the lower-grade animals of the earlier crosses have been disposed of. Twelve does, 2 years old and upward, are in milk this season, and there are on hand about 20 head of female yearlings and kids, most of which have either seven-eighths or fifteen-sixteenths Saanen or Toggenburg blood.

FARM SHEEP DEMONSTRATIONS.

The work of farm sheep demonstrations was continued by 12 specialists in Connecticut, Indiana, Iowa, Maine, Massachusetts, Michigan, Mississippi, Missouri, New York, North Carolina, Texas, and West Virginia. While they were largely called upon to aid beginners in sheep raising, yet they were able to carry on work especially planned to result in more general use of methods known to be

most profitable in different localities. This was mainly accomplished by means of demonstration flocks, 75 of which were established in Illinois, Indiana, and Missouri. The plan is for the county agent and the specialist to arrange with from one to three flock owners in a county to conduct the breeding, feeding, and management of their flocks in compliance with the teachings of experiments and the best practice applicable to the section, and to keep records. These flocks are used as subjects of field meetings and demonstrations. A large number of county associations of sheep raisers has been formed as a result of the joint efforts of county agents and specialists in sheep husbandry.

EMERGENCY WORK IN SHEEP HUSBANDRY.—On account of the great importance of an increase in wool and lamb production during the war, the work on farm sheep demonstrations was supplemented by emergency extension work in Arkansas, Florida, Idaho, Illinois, Indiana, Kansas, Louisiana, Michigan, New Hampshire, North Carolina, South Dakota, Tennessee, Texas, and Vermont, under cooperative arrangements with the extension departments of the State agricultural colleges. The chief duty of the bureau's specialists was to aid the county agents in giving advice and direction to persons inexperienced in sheep raising and in endeavoring to bring about the largest possible returns of wool and meat from older flocks. A large number of new flocks were established. Demonstration meetings were held to explain how to select breeding ewes and rams, how to shear the sheep and prepare the wool for market, docking and castrating lambs, and proper management for procuring the maximum growth of lambs and for maintaining the health of the flock.

HORSE AND MULE INVESTIGATIONS.

BREEDING AMERICAN CARRIAGE HORSES.

The cooperative agreement with the Colorado experiment station at Fort Collins for experiments in breeding American carriage horses terminated June 30, 1919. July 1, 1919, the work was transferred to Buffalo, Wyo., where it will be conducted in cooperation with the State of Wyoming as a project for the development of a horse of general utility adapted to western range and farm conditions. Prior to terminating the work at Fort Collins the stud consisted of 7 aged stallions, 2 4-year-old stallions, 1 3-year-old stallion, 2 2-year-old stallions, 20 aged mares, 2 4-year-old mares, 7 3-year-old mares, 10 2-year-old fillies, and 13 1-year-old fillies, a total of 64 animals. Twelve stallions and 25 mares and fillies were selected for retention in the stud to be transferred to Wyoming. The remaining 27 animals were retained by the Colorado station.

The standard-bred stallion Harvest Aid 63908 was purchased by the department last spring and added to the stud. This stallion is a brown three-year-old, standing 15.2½ hands and weighs 1,180 pounds in his present form.

BREEDING MORGAN HORSES.

The breeding of Morgan horses at the Morgan horse farm, Middlebury, Vt., is progressing very satisfactorily, and uniformity is being attained in the animals produced. At the close of the fiscal

year there were 9 mature stallions, 11 young stallions, 30 mares and fillies, and 7 geldings (including 3 draft-work geldings), a total of 57 animals. Sixteen animals were eliminated from the stud on account of being unsuitable for breeding purposes, and two died. Four of the mature stallions were sent out to various sections of Vermont for use in the Army horse-breeding work. The mare Grief, by Snoqualmie and out of Gertrude, was added to the stud October 31, 1918.

The test in feeding weanling colts grain and hay ad libitum has given excellent results in maximum growth and development without harmful effects. The average daily feed consumed by the colts in this test was as follows: Oats, 8.52 pounds; bran, 3.39 pounds; alfalfa, 3.25 pounds; timothy, 4.91 pounds.

BREEDING HORSES ON INDIAN RESERVATIONS.

At the close of the fiscal year 617 mares had been bred to the 12 stallions maintained under the project for breeding horses on Indian reservations, with headquarters at Eagle Butte, S. Dak.

BREEDING HORSES FOR MILITARY PURPOSES.

The plan of breeding horses for military purposes which was begun under congressional authority in 1913 was continued under the same terms as before. Seven hundred and eighty-six mares were bred to 33 stallions.

COTTONSEED MEAL FOR FARM WORK STOCK.

The test in feeding cottonseed meal to work horses and mules at the Beltsville farm, begun during the preceding fiscal year, was continued. Results indicate that 1 pound per day per 1,000 pounds live weight is the most satisfactory quantity to feed to work animals. Cottonseed meal, like any other high-protein feed, must be fed with care to horses and mules. Harmful effects were apparent from feeding the meal in large quantities.

POULTRY INVESTIGATIONS.

POULTRY FEEDING.

Experiments in feeding hens for egg laying are in progress at the Beltsville farm in 27 feeding pens, 25 of which contain 30 hens each and 2 contain 50 hens each. The results of 1918 on the high vegetable protein rations were not entirely satisfactory. New experiments are being conducted this year in reducing the amount of the vegetable protein (soy-bean meal, peanut meal, and velvet-bean meal) and increasing the animal protein (meat scrap). The mash fed last year contained 10 per cent each of vegetable and animal protein, while this year the new pens receive 15 per cent meat scrap and 5 per cent of the high vegetable protein feed. Up to the close of the fiscal year the egg yield had continued good and had not been adversely affected by the summer weather, as was the case with the ration fed last year. The birds in the pen receiving peanut meal have slightly outlaid the others, being followed by those receiving soy-bean meal and velvet-bean meal in the order given. Apparently the ration being used this

year is a considerable improvement over the one previously used. The pen receiving 10 per cent of cottonseed meal and meat scrap in the mash continues to give good results.

The experiment with feeding garbage is being continued through its second year with a fairly good egg yield but with excessive mortality, due apparently to the garbage. The pen on cooked vegetables with a rather light grain ration laid fairly well during the first year and is also laying particularly well the second year. Continued good results are being obtained on the ration which does not contain any wheat. Special tests on using one feed and its by-products supplemented with meat scrap, including such feeds as oats, barley, and corn, are being tried with fair results, but are not giving as good results as where two grains are used. Continued data on the feed cost of producing eggs from different breeds on different rations are being accumulated.

POULTRY BREEDING.

Practically all the hens on the farm, whether in feeding or breeding pens, are trap-nested, and all the chicks are pedigree hatched, so that their parents are known. In breeding for egg production the plan has been to continue matings of females of good production to males out of good producing females, at the same time selecting for quality in standard requirements.

In the experiments in grading up mongrel flocks by the continued use of purebred males the third generation of grades has been obtained and bred. The Barred Plymouth Rock grades show marked uniformity in color and type, and the White Plymouth Rock grades show improvement in this respect but do not yet all come pure white in color. In both kinds of grades individuals occur which so closely resemble purebreds that it is impossible to tell the difference by their appearance.

Further progress has been made in the difficult work of establishing a new breed with the combination of characters desired.

In carrying on the breeding work 70 different matings were made and about 3,000 chicks were hatched. The installation and operation of a mammoth incubator has helped greatly in the hatching.

PIGEON AND SQUAB INVESTIGATIONS.

The pigeon investigations have been continued along the lines previously followed, giving another year's data on the cost of raising squabs for market from the different varieties of pigeons commonly kept for that purpose. Investigations in the breeding and training of homing pigeons are being continued.

TURKEY AND GUINEA INVESTIGATIONS.

Information regarding the raising of turkeys and guinea fowl is being collected from time to time so that bureau publications on these subjects may be kept up to date.

POULTRY EXTENSION.

The emergency campaign to stimulate poultry production, carried on in cooperation with the State extension forces, begun in the fall of 1917, was continued throughout the past fiscal year. Since the signing of the armistice the efforts have been directed toward more

efficient methods rather than to concentrate entirely on increased production. The work was carried on in 29 States by 41 field men. In 1919 there was reported from 21 of these States an average increase of 26.5 per cent in poultry production over the preceding year; 5 States reported a normal production, 1 slightly above normal, and only 2 showed a slight decrease, due principally to the high cost of feeds as compared with the price received for the finished products.

POULTRY CLUBS.

Nine poultry-club agents or specialists working in 8 States in the calendar year 1918 supervised the conduct of 2,151 boys' and girls' poultry clubs with an enrollment of 31,095 members, an increase of 107.3 per cent over the preceding year. These club members hatched 320,869 chicks and raised 233,123 mature fowls. They produced \$146,529.09 worth of poultry and eggs for market and breeding purposes, and the total value of their receipts and stock on hand at the end of the year amounted to \$403,690.46. One hundred and thirty-five poultry-club exhibits were held, at which 1,405 members exhibited 4,825 birds and 447 dozen eggs, and the total amount of special and cash prizes awarded to the members making these exhibits amounted to \$4,388. The average profit per member reporting was \$23.53.

ANIMAL GENETICS.

The inbreeding of guinea pigs has been carried to the twentieth generation wholly by mating brother with sister. Crossbreeding experiments, with the inbred families as material, have now been carried on for more than three years. The results of the past year are in agreement with those for the previous years. No very obvious degeneration has appeared in the inbred stock. There has, however, been some decline in vigor. Fertility, including both size and frequency of litters, has suffered the most. Experiments on the resistance to tuberculosis of the different inbred families and of the crossbreds have been begun in cooperation with the Phipps Institute, of Philadelphia. A new statistical method has been developed in connection with investigations on the relative importance of the various factors which determine coat color, rate of growth, etc.

ANIMAL HUSBANDRY EXPERIMENT FARM.

Besides the experimental work carried on at the Animal Husbandry Division farm at Beltsville, Md., the general development of the farm has been continued. Progress has been made in drainage, completion of buildings, water system, soil improvement, improvement of grounds, and several minor projects. Drainage of all except woodlands has been completed; 16,649 feet of drain tile were laid during the year, making a total of 78,191 feet laid since the farm was acquired. All the large buildings and most of the portable houses have been newly painted.

CERTIFICATION OF ANIMALS IMPORTED FOR BREEDING PURPOSES.

Under the provisions of paragraph 397 of the tariff act of October 3, 1913, certificates of pure breeding were issued for 168 horses and 92 dogs.

DAIRY DIVISION.

On account of the high cost of feed and other materials used in dairying, the Dairy Division, under B. H. Rawl, chief, has given special attention to economical production through the use of improved dairy cows and proper feeding. To improve the dairy cows the use of better sires and the selection of cows has been encouraged by the promotion of bull associations and cow-testing associations, and this work has met with a hearty response from the producers. Bull associations, which make it possible for owners of small herds to have the use of good bulls and at the same time to utilize good bulls to the fullest advantage, have been especially successful. Extensive breeding projects have been begun at the Dairy Division experiment farm at Beltsville, Md., and also in cooperation with various States, for the purpose of determining the principles of breeding for establishing high-producing herds.

Much time has also been devoted to encouraging the fuller utilization of milk and milk products, and a special campaign was carried out to increase the consumption of milk where a surplus of this product was found. Improvement of dairy products has been undertaken by emphasizing the importance of sanitation on the farm and the necessity for the thorough cleaning of dairy utensils. Investigations in economy of production, such as fuel and steam utilization in factories, have been continued. Studies in the manufacture of foreign varieties of cheese have been extended and results of several years of experimentation with Swiss and Roquefort cheese have been put into practical use in the manufacture of these cheeses on a commercial scale.

Efforts were made to assist in war work with all facilities at the division's command. Surveys and inspections of milk supplies were made in Army cantonments, and assistance was rendered the Navy Department through the inspection of butter. Work was done also on other war problems.

DAIRY EXTENSION.

Extension work in dairying serves to carry this industry into new sections, to introduce new practices developed as the result of research, and in general to unify methods throughout the United States. This work is generally carried on in connection with various State agricultural colleges. Cow-testing-association and bull-association work are the chief lines of activity.

SOUTHERN DAIRYING.

Efforts of the extension forces have been directed toward general dairy advancement in the South and the building up of a cheese industry in the mountain sections. Among the more important specific accomplishments have been the organization of 21 bull associations and 7 new cow-testing associations, reorganizing 5 cow-testing associations, assistance in the purchase of 1,849 head of cattle (among which were 169 purebred bulls and 771 purebred females), and the erection of 64 silos, 48 new barns, and many other smaller buildings. The great popularity of bull associations and the large number of dairy cattle brought into the Southern States give evi-

dence of interest and progress in the improvement of dairy stock. Good results of the work for the development of the creamery industry are the growing popularity on the market of Mississippi butter and the fact that local creameries of central Tennessee are proving successful. The benefits of eradicating the cattle ticks are being realized more and more in the advancement of the dairy industry.

WESTERN DAIRYING.

During the first half of the fiscal year the extension work for the development of the dairy industry in the Far West was continued under unfavorable conditions, such as a shortage of labor, high prices of feed, and uncertain markets. Later, however, conditions were much improved. Dairy stock has been in great demand and there has been a widespread movement among producers to obtain pure-bred bulls. As a result of good cooperation among Federal, State, and county agents, cow-testing work has been given renewed life, bull-association work has been extended, and considerable interest has been taken in the utilization of creamery by-products. Silo construction has made greater progress than during any previous year. Agents of the Dairy Division assisted directly in the erection of 500 silos, which represent only a small part of the total number erected.

COW-TESTING ASSOCIATIONS.

Cow-testing associations, the formation and operation of which are encouraged and supervised by the Dairy Division, are made up of groups of dairymen who collectively hire a tester to keep records on production, butterfat test, and other data concerning each cow. During the first half of the fiscal year practically all testers were in military service and the work of the associations suffered severely. Since the return of the soldiers to civil life there has been a revival of association work and a marked increase in the number of active associations. The total number of associations that were active July 1, 1919, was 385, representing 10,000 herds with 167,313 cows, compared with 353 associations active July 1, 1918, representing 9,778 herds with 168,348 cows. Oklahoma, South Carolina, and Texas reported active associations for the first time. Wisconsin continues to lead in the number of associations, with a total of 103, Pennsylvania ranking second with 38, Illinois third with 27, and Ohio fourth with 25. The associations continue to practice extensively the cooperative buying of feed. In Michigan an agent in dairying selected feeds for one association which resulted in a saving of \$3,000.

STUDY OF COW-TESTING RECORDS.

The tabulation of records of 38,532 dairy cows from 110 cow-testing associations is nearing completion. The tabulations have brought out a number of interesting relations between milk production, butterfat test, butterfat production, and income over cost of feed. The average milk production was 5,936 pounds per cow and the average butterfat production 246 pounds. For each 50 pounds increase in production of butterfat there was an average increase of \$15 in income over cost of feed. In the case of each breed an increase in the use of the butterfat test was accompanied by an

increase in butterfat production and by a decrease in milk production. The larger cows excelled the medium and small cows in production of milk and butterfat. The results of this work are being prepared for publication.

COOPERATIVE BULL ASSOCIATIONS.

Bull associations have been found an inexpensive but very successful means of improving dairy cattle, and have therefore been very popular in sections where dairying is a new industry and the farmer's resources are limited. A greater number of really substantial cooperative bull associations have been formed this year than in any previous year since the movement started in this country, for out of a total of 82 associations now in operation 40 were organized during the past year. This work has been especially successful in the South. Requests for assistance from many States resulted in the selection of Georgia, Alabama, Mississippi, Louisiana, Texas, and Tennessee for association work. Associations were formed in each of these States except one. Work in the Western States was hampered by the lack of a director part of the year, but during the last six months of the year four substantial associations were organized, one each in Montana, Washington, Wyoming, and Oregon.

COMMUNITY DEVELOPMENT IN DAIRYING.

The project in community dairy development at Grove City, Pa., which was organized a few years ago as a means of demonstrating the value of intensive work in developing dairy communities, has now passed the experimental stage and has shown its value as a constructive influence in dairying. Many farmers, county agents, and bankers from all over the country have made inquiries or have visited Grove City with the idea of undertaking similar development in their localities. In this enterprise the department has worked in cooperation with patrons of the creamery, and with the local breeders' associations, the commercial club, and the local banks. The past year witnessed the building of 21 silos and the improvement of farm buildings of 112 of the creamery patrons.

The accredited-herd plan for eradicating tuberculosis and maintaining herds free from that disease has been well received. In the Grove City area 327 herds are under supervision of the Bureau of Animal Industry and the Pennsylvania State live-stock sanitary board. Four new clubs having for their object the development, improvement, exhibition, and sale of tuberculosis-free cattle have been organized.

Other cattle clubs organized in previous years have generally shown increased membership. The cow-testing association has been reorganized with 39 members and 411 cows. Interest in purebred dairy cattle has continued to increase; 58 of the creamery patrons purchased 133 registered dairy females and 48 patrons purchased purebred bulls.

SUPPRESSION OF INFECTIOUS DISEASES IN DAIRY HERDS.

In connection with the work relative to cow-testing and bull associations, work of an educational nature has been done to further the prevention and eradication of tuberculosis and contagious abortion.

Such work has been carried on in many States and has contributed to the marked popularity of the accredited-herd plan. In herds of these associations tested for tuberculosis by the Tuberculosis Eradication Division of the bureau, it was found in most cases that only a small per cent of the cows were diseased, but the elimination of the few disease spreaders before the herds could become badly infected was of great benefit and undoubtedly prevented later losses.

DAIRY DEMONSTRATION FARM, DENISON, TEX.

For several years a dairy farm near Denison, Tex., owned by a group of local businessmen, has been operated as a demonstration of the value of dairying under certain local conditions. This project was terminated during the year by the sale of the property by the owners, there having been a material increase in land values in that region as a result of oil development. During the last year of the project considerable terracing was done and many additions to equipment, improvements, and repairs were made from the earnings of the farm. The oat crop yielded well and the alfalfa crop was satisfactory, but the corn was only fair, because of dry weather.

STIMULATING PRODUCTION AND UTILIZATION OF DAIRY PRODUCTS.

In order to stimulate the production and consumption of milk and milk products for human food an educational campaign was carried on in numerous cities and small towns of the Northern States. This work was done principally among women. The objects were (1) to eliminate waste by a more comprehensive and varied utilization of dairy products, (2) to improve and enlarge the food supply, and (3) to encourage the dairy industry. The Dairy Division cooperated with the various States through the States Relations Service. The campaign was divided into two major projects, one dealing with the larger cities in States where a milk surplus was reported, and the other with the smaller towns and rural districts.

In the city campaigns a wide variety of methods was used, depending largely on local conditions. In general, however, the process consisted in obtaining a large degree of cooperation from the city authorities, health boards, etc., together with talks and demonstrations in schools, factories, and department stores. In many cases attractive exhibits were placed in store windows and extensive use was made of publicity through press notices or paid advertising. Posters showing the food value of milk were also used effectively.

An example of such a campaign is the work done in Detroit, Mich., where it was found that there was a 30 per cent surplus of milk during the spring months. To utilize this surplus and at the same time to increase the consumption of milk and dairy products an extensive campaign was organized. Thirty-five thousand circular letters were sent out to leading citizens, and cooperation was received from 20,000 club members, the principals and teachers of the city schools, visiting housekeepers, welfare workers, clergy, physicians, hotels, restaurants, etc. A total of 371 lectures were given in schools, reaching 69,000 children directly and their parents indirectly, and the visiting nurses and visiting housekeepers carried the message to thousands of homes. Congregations of 65 churches listened to milk sermons, and thou-

sands of factory employees and newspaper readers were also reached. Ten thousand posters were distributed and multitudes of people viewed window exhibits. As a result of the campaign a large per cent of the milk surplus was absorbed, milk sales increased, and sales of butter and cottage cheese increased materially. The board of health placed a high value on the campaign as a means of improving the health of the city. Similar campaigns were carried out in 16 cities of five States.

For the rural and small-town campaigns, agents in dairying were appointed for State-wide work in Iowa, Kansas, and Utah. In organizing the work in those States it was agreed that the colleges of agriculture were to train dairy workers. The extension departments, home demonstration agents, and in some States the county agents and club agents assisted with the work. The work in Iowa affords an example of how this type of campaign was conducted. In that State the value of milk was brought to the attention of school children by having them write essays on the subject, and 4,500 families were reached in this way. In the schools at Ames and Des Moines the value of milk as a food was demonstrated through tests in feeding fixed quantities of milk to a number of abnormal school children for periods ranging from 2 to 3 months. In all cases the results showed that milk caused additional gains in weight, and in many cases the children were reported by their teachers to be more alert mentally and easier to handle. In northeastern Iowa an educational campaign was conducted among rural schools and homes and resulted in an awakening among children and parents as to the value of milk as a food.

Efforts of the women dairy agents and of others who have helped in conducting farm-home dairy work in Southern States have been directed toward greater production of milk and more liberal use of milk and dairy products in the diet. Since a certain amount of milk is usually made into butter on the farm, demonstrations and instruction in improved methods of buttermaking have been given to farm women. The increase in production and use of milk was accomplished through the "Buy a cow" campaign, instruction in the care and feeding of cows and the proper care of the milk, demonstrations in cooking, buttermaking, and cheesemaking, and exhibits of dairy products.

As a result of this work, 41,000 families are now using more milk for drinking and cooking, 448 family cows have been purchased, and 1,042,542 pounds of cottage cheese were made by farm women. An indication of the interest aroused in modern methods of dairying is shown by the purchase of 16,247 pieces of improved dairy equipment. Exhibits and contests have also done much to stimulate interest in more and better dairy products.

DAIRY-MANUFACTURING INVESTIGATIONS.

CREAMERY IMPROVEMENT.

Special attention has been given problems relating to organizing, building, equipping, and operating creameries. While many States were included in this work, special attention and help have been given to creameries in the Southern States, where the comparative

newness of the industry made assistance in creamery development of vital importance. As a result of these efforts the manufacturing methods and the sanitation of the plants in many localities are now equal to those of the best dairy sections of the country. Much of this progress is due to improvement in methods of dairy farming and the resulting improvement in the quality of the cream brought to the creameries. In bringing about these results the field agents have worked largely with the farmers of small means who depend on dairying for a livelihood.

The high prices of coal and electric power have given new importance to economy and efficiency in power and refrigeration. A number of creameries were given assistance in building refrigerators, and specifications were furnished for exhaust-steam water heaters, resulting in material savings to the plants concerned. Exhaust-steam water heaters and hot-water boiler-feed pumps were installed by 45 creameries. Equipment for using exhaust steam for pasteurizing cream was installed by 6 creameries, balanced valves were put in 3 plants, and electric motors installed by 3 plants.

THE GROVE CITY CREAMERY.

The addition to the creamery plant at Grove City, Pa., has been completed, and cheese of the Camembert, Roquefort, and Swiss varieties is now being manufactured in an effort to encourage production in the United States of these cheeses, which heretofore have been largely imported.

Despite the high cost of feed and the curtailing of milk production, the Grove City creamery has surpassed the records made in 1918 in practically all lines, and the total business done has increased from \$375,595 in 1918 to \$520,486 in 1919. For the past few months the creamery has received larger premiums in price for its products than ever before.

CHEESE-FACTORY EXTENSION.

Much work has been done by the Dairy Division's field men in determining suitable localities for the manufacture of Cheddar cheese and demonstrating the proper methods of organizing, building, equipping, and operating cheese factories, training cheesemakers, and otherwise giving assistance in both the manufacture of cheese and the production of the milk for its manufacture. Several factories have been established as a result of this work, especially in the mountainous sections of the Southeast. The cheese produced has been generally of good quality and dealers have been eager to buy it at good prices.

INSPECTION OF BUTTER FOR THE NAVY.

The large quantities of butter contracted for by the Navy required extensive supervision by this department in the making of the butter and in investigating the results of various methods of manufacture and determining the effect of storage on the butter. Considerable time was spent in inducing creameries to make butter under Navy contract, also in obtaining inspectors and in making certain that the specifications were properly carried out. Although the packing of the butter was carried out under pressure of war conditions, the

quality proved to be high. Seven supervisors and 90 inspectors were engaged in this work, which involved over 9,000,000 pounds of butter produced in 119 creameries. The butter was produced largely in Minnesota, Iowa, and California, with smaller quantities from Wisconsin, Michigan, and Pennsylvania.

When the Government commandeered butter held in storage in the principal markets of the United States, the butter allotted to the Navy was scored by department representatives at the request of the Navy Department.

INSPECTION OF RENOVATED-BUTTER FACTORIES.

The supervision of renovated-butter factories, consisting of an inspection of the sanitary condition of the factories and the approval of wrappers and cartons used, was conducted at 15 plants, whose output for the fiscal year amounted to 16,667,455 pounds. This is a decline of 14 per cent from the preceding year and of 62.75 per cent in 10 years.

MILK INVESTIGATIONS AND DEMONSTRATIONS.

SANITARY SURVEYS OF CITY MILK SUPPLIES.

Surveys on the sanitation of the milk supplies of several cities were made. These surveys were more detailed than in former years and took into consideration the source and handling of the milk supply, together with laboratory and inspection methods used in safeguarding its quality. Detailed bacteriological tests were made in many instances, and considerable help was given to the city authorities in the preparation of new milk ordinances. In the course of this work 478 dairy farms and 415 city milk plants were inspected, 3,532 bacterial counts were conducted, and 95 chemical tests were made.

SANITARY SURVEYS OF MILK SUPPLIES FOR ARMY AND NAVY.

Sanitary inspection work for safeguarding the milk supplies of Army cantonments and naval bases and hospitals was continued and extended at the request of the United States Public Health Service. Careful and thorough investigations of the source and handling of milk were made, and raw milk, sour milk, and repasteurized milk were excluded. This work was done in 9 cantonment zones, with specially complete surveys at Houston, Waco, and San Antonio, Tex., and Lawton, Okla.

MILK CONTESTS.

Each year the milk contest is proving itself more valuable as a means of improving the city milk supply and keeping the quality at a high standard. During the year five contests were held in five States and a total of 264 samples of milk and cream were given a complete score. Criticisms and suggestions for improvement were made to exhibitors.

MILK-PLANT MANAGEMENT.

The work in milk-plant management consisted largely of personal assistance in the operation of milk plants and help in the organizing of central plants. Assistance of various kinds was also given by correspondence, including the drawing of numerous special floor

plans and making estimates of cost for proposed plants, collecting data relative to cost and method of operation, and giving special aid in the selection of equipment. The field work has been largely the gathering of data and assisting new plants in planning construction and equipment. At Atlanta, Ga., for example, the Dairy Division representative worked in cooperation with the health department in familiarizing the dealers with the new pasteurizing equipment required and helping the foremen to systematize the work, and in Minnesota, at the request of the State board of health, milk plants were studied and recommendations were made for the improvement of pasteurizing methods and equipment. Work of this nature was carried on in a large number of cities in 14 States.

MILK IMPROVEMENT AT GROVE CITY, PA.

Through experiments at the Grove City creamery an effort was made to work out some plans for improving the quality of the market milk and to procure better milk for cheesemaking. As a result the average of the bacterial counts in the milk during the summer of 1919 was even lower than the preceding winter's average. Probably the most important step taken in connection with sanitation was the adoption of the grading system of milk, by which milk sent in by the patrons is graded for bacteria, temperature, farm conditions, and sediment. The premiums paid on milk which received a high score have done much to improve the quality of the milk delivered by the patrons of the creamery.

METHOD OF CLEANING MILKING MACHINES.

The increase in the use of milking machines has made it desirable to devise some method of cleaning and sterilizing that will prevent excessive numbers of bacteria. After a study of the construction of various machines and methods of cleaning and sterilizing them under farm conditions, a system of cleaning has been devised which has given good results in lowering bacterial counts and checking the spread of garget, but further work is required on the problem.

REQUIREMENTS FOR MILK PRODUCTION.

Studies of the various requirements for milk production have reached a stage where some definite information is now available. A two-year study on a group of dairy farms near Vergennes, Vt., has been completed and tabulations have been made on the requirements and cost of producing 100 pounds of milk and the requirements for keeping a cow for one year. Similar data have been obtained from two-year studies in Indiana and North Carolina. Experiments of a like nature have been in progress for one year on a group of dairy farms near Omaha, Nebr.; Amite, La.; and Mount Vernon, Wash., and more recently another has been begun at Middletown, Del.

DAIRY RESEARCH LABORATORIES.

BACTERIOLOGY.

The Dairy Division laboratories, in addition to research pertaining strictly to the dairy industry, have continued to carry on work of a broader character with a view to contributing to the knowledge

and practical application in general. Some work of the latter nature too technical to be described in this report is in course of publication.

A study of streptococci from sour milk, feces, and the udder has resulted in the working out of methods for separating and distinguishing these organisms, and has shown the existence of a typical lactic streptococcus. Media which promise to be of considerable value in bacteriological technique have been developed by the substitution of yeast extract for the usual beef extract. Progress has also been made in developing a test for quality of milk through work with sporogenes.

MILK SECRETION.

Further studies on milk secretion have demonstrated that there is a close relation of the phosphorus and calcium content of the blood to the milk-producing function. It has been shown that a deficiency of phosphorus in the rations for cows and calves has a detrimental effect on milk secretion and growth. A remedy for this condition was found in the addition of sodium phosphate to rations deficient in phosphorus. Work with dairy cows has shown that the feeding of phosphorus and calcium results in a decided beneficial effect on the milk flow, in both amount and fat content. Balance experiments have shown also that the conditions under which it is necessary to keep cows while conducting work of this kind have a disturbing effect on the digestive processes. This observation calls for improvements in equipment used in the future.

CONDENSED AND EVAPORATED MILK.

Investigations have been undertaken with various forms of condensed and evaporated milk, with the general purpose of improving the physical condition and keeping qualities of these products. Studies on the curdling of evaporated milk in sterilizing have been continued, and progress has been made on the problem of preventing the thickening of sweetened condensed milk on standing.

The theoretical sugar solution required to inhibit bacterial growth in the condensed milk has been determined within narrow limits. A study of the bacteria and yeast which might be involved in these changes has resulted in increased knowledge of their behavior.

Work with certain molds has positively demonstrated that the "buttons" of condensed milk are caused by this growth. Further results have shown that in commercial production the condensed milk may be produced without danger from molds if sealed under the vacuum produced by the ordinary vacuum pump.

Tests to determine the suitability of milk for condensing purposes indicated that neither the acid test alone nor the alcohol test alone nor a combination of the two was satisfactory.

ICE CREAM.

A substitute for a large part of the cane sugar in ice-cream making was found through experiment, and the formula was widely disseminated. The preparation of pure butterfat for ice cream and reconstituted milk has not given satisfactory results.

CHEESE.

A special effort has been made to apply the new methods of making the Swiss type of cheese on a commercial basis. In most of the factory trials this method was a success and resulted in the production of cheese of uniformly high quality. Before extensive work can be done with factories, however, a practicable means of distributing eye-forming cultures must be devised. The question of the relation of the culture and formation of eyes has been established beyond question.

In an attempt to introduce into this country the manufacture of various cheeses now imported, cheeses of the Camembert and Roquefort varieties were made successfully on a commercial scale at the Grove City creamery, but so far none have had a fair trial on the market.

UTILIZATION OF CREAMERY BY-PRODUCTS.

Considerable work has been done on the development of casein for use in waterproof glue, and a casein of low ash and acid has already been produced.

A method of producing casein from buttermilk is also being worked out. Using a solvent to extract the fat from the buttermilk, small lots of casein have been made, and this product was found to be of general good quality and low in fat and ash, but had the objection of dissolving slowly.

Work is now in progress with the object of developing a method of utilizing whey as a human food. It is probable that whey represents a greater actual loss of food than skim milk, because its feeding value is not generally recognized. Primost and Ricotta cheeses, which are made from whey, were produced at the Grove City creamery, but the demand has been limited. The use of these cheeses might be extended if their value for cooking could be brought to the attention of housekeepers. Investigations have also been begun on the utilization of whey solids in the form of poultry feed.

SILAGE INVESTIGATIONS.

Studies on the value and composition of corn plants and sunflower plants for silage have shown that good silage can be made from the latter as well as the former. Various tests have been made on the composition of these crops at different stages of maturity, but no correlation has been established between the composition of the plants and the quality of the silage.

WAR ACTIVITIES.

A considerable part of the time of the laboratory staff was spent in lending aid in preparing material necessary to carry on the war. Assistance was rendered to the Army Medical Corps by providing laboratory facilities for drying typhoid vaccine. Probably the most important work, however, was the developing on short notice of a method of making casein of more than ordinary purity. This was necessary in the manufacture of the waterproof glue essential to the manufacture of airplane parts. Another war problem worked out

was the purification of oil-soaked cotton waste. This work was in progress and the process nearly perfected when the signing of the armistice made it advisable to discontinue the work.

DAIRY EXPERIMENT FARM.

Practical experimental work in various problems has been continued at the Dairy Division experiment farm at Beltsville, Md. The farm produces a large part of the feed required.

METHODS OF WATERING COWS.

Experiments on the influence of the method of watering on the quantity of water drunk by cows and the production of milk have been completed, and a manuscript describing the work has been prepared. The difference between watering at will and twice a day was not pronounced; the cows with the water continuously available drank less and yielded more, the gains in the body weight being the same. Both of these systems of watering when compared with watering once a day showed an increase in water consumption, milk production, and a gain in live weight. These experiments point to the tentative conclusion that the advantage of water continuously lies mainly in the saving of labor rather than in a greater production of milk.

REGULAR VERSUS IRREGULAR MILKING.

To determine the effect of regular and irregular milking on the milk yield, five cows were used in an experiment in which regular and irregular milking were practiced alternately, in periods of 25 days each. The results show that with cows yielding an average of 20 or 25 pounds of milk daily there was no difference between regular and irregular milking so far as production was concerned. The feeding hours were regular throughout. It is thought that more difference might be found if both feeding and milking were irregular, as in the case on many farms.

GRUELS FOR CALVES.

As a result of experiments with the object of preparing a calf meal which would be cheap, easy to keep in liquid suspension, make good gains in weight and maintain the vigor of the calf, a mixture has been produced which largely meets these requirements.

FEED COST FOR RAISING HEIFERS.

In an effort to determine the cost of raising heifers, 11 calves were fed to the age of 1 year and 5 to the age of 2 years. The results showed the cost of raising heifers to 1 year of age to be \$72.42 and to the age of 2 years \$157.96, with feed at current prices in Maryland and under the system of management necessary at the Beltsville farm. These figures show the necessity of providing cheap feed, such as pasture, for heifers, and the necessity of thorough culling to avoid raising animals which will prove inferior.

DAIRY STATISTICS.

Considerable attention has been given to the gathering, compiling, and charting of statistical dairy information to meet the usual general demand as well as special requests from various war boards for such data. A circular on the trend of the dairy-cattle industry was published and material relating to the trend of the butter and cheese industries has been prepared for publication.

DAIRY ENGINEERING.

The Dairy Division has continued to deal with various engineering problems relating to dairying. Subjects given attention were the preparation of plans and specifications for buildings and machinery, the superintendence of construction, the inspection of materials and equipment and the designing and construction of apparatus, including work for the bureau and other institutions and for the dairy industry. Information has been furnished regarding dairy buildings and other problems in dairy engineering in reply to inquiries on these subjects, and 362 blueprints of various dairy buildings have been prepared for field men. Several new plans for dairy buildings were designed, including a creamery, a cheese factory, and a cow stable. A bulletin on the economical use of fuel was written and published.

DAIRY-CATTLE BREEDING.

A start has been made in the extensive dairy-cattle breeding experiments that were outlined in last year's report. The work deals with line breeding, inbreeding, and crossbreeding, the fundamental object being to determine the best method of developing the better-producing cows in large numbers. For work in line breeding as compared with the mating of unrelated animals a herd of 35 registered Holstein-Friesian cows has been established at the Beltsville farm, and the producing ability of the cows is now being tested. Other breeding projects are to be carried out cooperatively with various experiment stations.

A study of the unusually prepotent breeding animals of the Holstein-Friesian breed is almost completed. In the study of 126 sires which have daughters with yearly records that conform to certain arbitrary standards, which were established for this work, it was found that all but 14 of them traced back to five sires.

MEAT INSPECTION DIVISION.

The Federal meat inspection, conducted by the Meat Inspection Division, with Dr. R. P. Steddom as chief, reached the largest proportions in its history. The number of animals slaughtered was 20.6 per cent greater than in the preceding fiscal year and 21.6 per cent greater than the average for the last 12 years during which the present meat-inspection law has been operative.

INSPECTION OF DOMESTIC MEATS.

Inspection was conducted at 895 establishments in 263 cities and towns, as compared with 884 establishments in 263 cities and towns during the fiscal year 1918.

Inspection was begun at 84 establishments and withdrawn from 73 during the year, as compared with 83 and 74, respectively, during

1918. Inspection was withdrawn from 66 establishments on account of discontinuance of slaughtering or of interstate business, from 2 for violations of the regulations, from 4 by request, and from 1 because of consolidation with another establishment under inspection.

ANTE-MORTEM AND POST-MORTEM INSPECTIONS.

The ante-mortem and post-mortem inspections are given in the following tables:

Ante-mortem inspection of animals.

Class of animals.	Passed.	Suspected. ¹	Condemned. ²	Total inspected.
Cattle.....	11, 211, 937	96, 077	87	11, 308, 101
Calves.....	3, 658, 495	5, 348	18	3, 663, 861
Sheep.....	11, 277, 597	6, 240	14	11, 283, 851
Goats.....	125, 640	27	.....	125, 667
Swine.....	44, 322, 940	106, 977	2, 469	44, 432, 386
Total.....	70, 596, 609	214, 669	2, 588	70, 813, 866

¹ This term is used to designate animals found or suspected of being unfit for food on ante-mortem inspection, most of which are afterwards slaughtered under special supervision, the final disposal being determined on post-mortem inspection.

² For additional condemnations see succeeding tables.

Post-mortem inspection of animals.

Class of animals.	Passed.	Condemned.	Total inspected.
Cattle.....	11, 182, 442	59, 549	11, 241, 991
Calves.....	3, 665, 025	9, 202	3, 674, 227
Sheep.....	11, 253, 999	14, 371	11, 268, 370
Goats.....	125, 342	318	125, 660
Swine.....	44, 269, 584	128, 805	44, 398, 389
Total.....	70, 496, 392	212, 245	70, 708, 637

The next two tables show the diseases and conditions for which condemnations were made.

Diseases and conditions for which condemnations were made on ante-mortem inspection.

Cause of condemnation.	Cattle.	Calves.	Sheep.	Goats.	Swine.
Arthritis.....	.....	.....	.....	.....	2
Ascites.....	.....	.....	.....	.....	1
Blackleg.....	1	.....	.....	.....	.....
Emaciation.....	2	2	.....	.....	9
Hemorrhagic septicemia.....	1	.....	10	.....	.....
Hog cholera.....	.....	.....	.....	.....	2, 388
Injuries.....	.....	.....	.....	.....	6
Milk fever.....	1	.....	.....	.....	.....
Pneumonia.....	9	1	1	.....	48
Polyarthritis.....	.....	.....	.....	.....	5
Pregnancy and recent parturition.....	12	.....	1	.....	.....
Rabies.....	56	10	.....	.....	.....
Septicemia.....	.....	.....	.....	.....	5
Temperature.....	2	5	2	.....	.....
Tetanus.....	1	.....	.....	.....	.....
Texas fever.....	1	.....	.....	.....	.....
Tuberculosis.....	1	.....	.....	.....	.....
Tumors and abscesses.....	.....	.....	.....	.....	5
Total.....	87	18	14	.....	2, 469

Diseases and conditions for which condemnations were made on post-mortem inspection.

Cause of condemnation.	Cattle.		Calves.		Sheep.		Goats.		Swine.	
	Car-casses.	Parts.	Car-casses.	Parts.	Car-casses.	Parts.	Car-casses.	Parts.	Car-casses.	Parts.
Actinomycosis.....	350	109,795	30	1,658	.....	52	.....	6	2	21
Adenitis.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Arthritis.....	.....	15	.....	3	.....	33	.....	.....	.....	16
Asphyxia.....	1	.....	10	.....	5	.....	.....	.....	1,329	.....
Atrophy.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Autointoxication.....	.....	.....	.....	.....	47	.....	.....	.....	2	.....
Blackleg.....	20	.....	8	.....	.....	.....	.....	.....	.....	.....
Bone diseases.....	11	5	.....	.....	1	.....	.....	.....	59	2
Caseous lymphadenitis.....	.....	.....	.....	.....	1,481	19	24	9	.....	.....
Cellulitis.....	.....	.....	.....	.....	.....	.....	.....	.....	4	236
Congestion.....	13	.....	7	.....	23	.....	.....	.....	44	.....
Contamination.....	2	193	2	64	.....	.....	.....	.....	256	1,030
Cysticercus.....	251	397	16	3	111	7	.....	.....	312	14
Dropsical diseases.....	9	.....	12	1	6	.....	.....	.....	57	1
Emaciation.....	8,043	.....	1,971	.....	5,148	.....	217	.....	728	.....
Exhaustion.....	.....	.....	.....	.....	.....	.....	.....	.....	4	.....
Frozen.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....
Gangrene.....	87	.....	12	.....	12	.....	.....	.....	22	.....
Hernia.....	4	.....	1	.....	17	.....	.....	.....	77	.....
Hof cholera.....	.....	.....	.....	.....	.....	.....	.....	.....	24,131	.....
Hydronephrosis.....	.....	.....	.....	.....	1	.....	.....	.....	3	.....
Icterus.....	71	.....	91	.....	1,488	.....	10	.....	2,825	.....
Immaturity.....	.....	.....	3,131	.....	.....	.....	.....	.....	.....	.....
Inflammation.....	.....	15	.....	2	.....	.....	.....	.....	.....	2
Injuries, bruises, etc.....	2,553	560	449	107	435	107	14	2	725	6,577
Leukemia.....	416	.....	18	.....	15	.....	.....	.....	133	.....
Melanosis.....	35	5	29	5	19	.....	4	.....	78	1
Moribund.....	12	.....	7	.....	19	.....	.....	.....	82	.....
Neerobacillosis.....	6	.....	2	22	1	5	.....	.....	4	.....
Necrosis.....	8	515	.....	3	1	.....	.....	.....	4	1
Parasitic diseases.....	4	.....	.....	.....	27	.....	1	.....	138	1
Phlebitis.....	.....	.....	145	.....	.....	.....	.....	.....	.....	.....
Pneumonia, peritonitis, metritis, enteritis, pleurisy, etc.....	6,343	.....	1,503	.....	4,789	.....	32	.....	19,094	.....
Pregnancy and recent parturition.....	28	.....	.....	.....	60	.....	3	.....	31	.....
Septicemia, pyemia, and uremia.....	2,801	.....	580	.....	557	.....	11	.....	10,798	.....
Sexual odor.....	.....	.....	.....	.....	.....	.....	.....	.....	884	.....
Skin diseases.....	1	.....	1	.....	.....	.....	.....	.....	39	.....
Texas fever.....	263	.....	620	.....	.....	.....	.....	.....	.....	.....
Tuberculosis.....	37,600	53,652	508	370	12	.....	.....	.....	65,837	418,402
Tumors and abscesses.....	611	1,639	49	241	96	107	1	.....	1,308	7,126
Total.....	59,547	166,791	9,202	2,479	14,371	330	318	17	128,805	433,433

The following table shows the total condemnations on ante-mortem and post-mortem inspections combined:

Summary of condemnations.

Class of animals.	Animals or carcasses.	Parts.
Cattle.....	59,636	166,791
Calves.....	9,220	2,479
Sheep.....	14,385	330
Goats.....	318	17
Swine.....	131,274	433,433
Total.....	214,833	603,050

In addition to the foregoing, the carcasses of 89,873 animals found dead or in a dying condition were tanked, as follows: Cattle, 5,237; calves, 4,784; sheep, 8,813; goats, 161; swine, 70,878.

INSPECTION OF MEAT AND PRODUCTS.

The inspection and supervision of meats and products prepared and processed are shown in the following table, which is a record only of supervisory work performed and not a statement of the aggregate quantity of products prepared. The same product is sometimes duplicated by being reported in different stages of preparation under more than one heading.

Meat and meat food products prepared and processed under inspection.

Kind of product.	Pounds.	Kind of product.	Pounds.
Placed in cure:		Meat extract.....	3,460,874
Beef.....	327,360,122	Lard.....	1,256,042,851
Pork.....	3,717,838,052	Lard oil.....	618,123
All other.....	2,588,734	Lard stearin.....	514,218
Sausage, chopped.....	667,602,113	Compound and other substitutes.....	469,731,660
Canned product:		Pork to be eaten uncooked.....	42,165,696
Beef.....	483,972,721	Oleo stock and edible tallow.....	58,768,630
Pork.....	143,345,433	Oleo oil.....	138,700,323
All other.....	4,940,949	Oleostearin.....	69,339,566
Sterilized product:		Oleomargarin.....	251,169,778
Beef.....	4,045,975	Miscellaneous products.....	1,516,694,094
Pork.....	10,132,470		
All other.....	8,857	Total.....	9,169,042,049

The following quantities of meat and meat food products were condemned on reinspection on account of having become sour, tainted, putrid, unclean, rancid, or otherwise unwholesome: Beef, 15,898,479 pounds; pork 14,113,246 pounds; mutton, 152,981 pounds; veal, 116,016 pounds; goat meat, 42,598 pounds; total, 30,323,220 pounds.

MARKET INSPECTION.

Market inspection was begun during the fiscal year at two cities, making a total of 45 cities at which this inspection is maintained in order that interstate deliveries of meats and products may be made therefrom.

MEAT AND PRODUCTS CERTIFIED FOR EXPORT.

The following products were certified for export: Beef and beef products, 714,706,213 pounds; mutton and mutton products, 3,297,395 pounds; pork and pork products, 2,774,067,187 pounds, a total of 3,492,070,795 pounds. In addition 536 certificates were issued covering the export of 15,071,507 pounds of inedible animal products.

EXEMPTION FROM INSPECTION.

The provisions of the meat-inspection law requiring inspection usually do not apply to animals slaughtered by a farmer on a farm nor to retail butchers and dealers supplying their customers. The retail butchers and dealers, however, in order to ship meat and meat food products in interstate or foreign commerce, are required first to obtain certificates of exemption. The number of exemption certificates outstanding at the close of the fiscal year was 2,551, an increase of 43 over the preceding year. During the year 103 certificates were canceled, 99 on account of the dealers retiring from business or ceasing

to make shipments, and 4 for violations of the regulations. During the year 31,470 shipments were made by retail dealers and butchers holding certificates of exemption, as compared with 45,524 shipments during the fiscal year 1918. The shipments of the year covered products as shown in the following table:

Shipments by retail dealers and butchers under certificates of exemption from inspection.

Product.	Number.	Pounds.	Product.	Number.	Pounds.
Beef, carcasses (729 quarters)	182	75,232	Cured meats.....		190,525
Veal, carcasses.....	22,354	2,005,827	Lard.....		10,655
Sheep, carcasses.....	176	9,185	Sausage.....		50,663
Swine, carcasses.....	399	53,654	Miscellaneous (scrapple, tripe, headcheese, etc.).....		22,283
Beef, fresh.....		538,288	Total.....	23,111	3,346,214
Veal, fresh.....		155,219			
Mutton, fresh.....		110,176			
Pork, fresh.....		124,507			

During the year 60,197 interstate shipments were made of meats and meat food products from animals slaughtered by farmers on the farm, as compared with 73,746 shipments made during the fiscal year 1918. The following table shows the products covered by these shipments:

Shipments of farm-slaughtered products under exemption from inspection.

Product.	Number.	Pounds.	Product.	Number.	Pounds.
Beef, carcasses (2,662 quarters).....	665	259,985	Pork, fresh.....		161,910
Calves, carcasses.....	82,881	7,382,960	Cured meats.....		648,713
Sheep, carcasses.....	2,899	89,157	Lard.....		151,248
Swine, carcasses.....	8,716	1,140,824	Sausage.....		118,049
Beef, fresh.....		39,052	Miscellaneous (scrapple, tripe, headcheese, etc.).....		20,500
Veal, fresh.....		49,014	Total.....	95,071	10,066,055
Mutton, fresh.....		4,643			

INSPECTION OF IMPORTED MEATS.

The following table shows the inspection of imported meats and meat food products for the fiscal year, representing an increase of 204.8 per cent over the inspections for the preceding year.

Imported meat and meat food products inspected.

Country of origin.	Fresh and refrigerated meats.		Cured and canned meats.	Other products.	Total weight.
	Beef.	Other classes.			
Argentina.....	451,456	38,781	79,278,623	114,029	79,882,889
Australia.....		33,415	40,185	1,015,940	1,089,540
Brazil.....			6,131,237		6,131,237
Canada.....	24,422,629	8,803,590	8,819,615	3,502,833	45,548,717
Uruguay.....	483,170		28,508,129		28,991,299
Other countries.....	6,018,521	1,928,777	7,138,323	3,181,839	18,267,460
Total.....	31,375,776	10,804,563	129,916,112	7,814,691	179,911,142

The following statement shows the condemnations of imported meats and the amounts refused entry on account of lack of foreign certificates or other failure to comply with the regulations.

Import meat products condemned or refused entry.

Product.	Con- demned.	Refused entry.
Beef.....	329,270	466,400
Veal.....	200	
Mutton.....	36	
Pork.....	10,832	35,396
Total.....	340,358	501,802

INSPECTION FOR OTHER DEPARTMENTS OF THE GOVERNMENT.

By request of the Navy, War, and Interior Departments reinspections of meats and meat food products to determine whether they were wholesome and conformed to the specifications were made during the fiscal year. Inspections were made at 50 places for the Navy Department and 68 for the War Department. The following table shows the amounts of such inspections.

Inspection for other branches of the Government.

Department.	Inspected.	Rejected.
	<i>Pounds.</i>	<i>Pounds.</i>
Navy Department.....	173,463,509	5,200,846
War Department.....	114,273,114	4,791,392
Interior Department (Indian Affairs).....	497,228	4,300
Marine Corps.....	9,931	
Panama Railroad.....	4,784	
Total.....	288,248,566	9,996,538

LABELING OF MEAT AND PRODUCTS.

The law provides for the approval of labels and other markings previous to their use on meat and meat food products, and prohibits the application of false or deceptive names. The regulations made under these provisions of law require that sketches of new trade labels and other markings be submitted for official approval, to be followed by the submission of the finished labels and markings for final approval. There were submitted during the year enormous quantities of materials, including labels, cartons, stencils, box dies, brands, and tags, as well as inserts placed inside of meat containers, and advertising matter bearing copies or reproductions of the Federal meat-inspection legend. Large numbers of these were found to contain false and misleading statements concerning the character or composition of the product represented and were disapproved.

NET WEIGHT AND VOLUME LAW.

The net weight and volume amendment to the food and drugs act, being applicable to meat and meat food products, is administered by the Meat Inspection Division in establishments under the Federal meat inspection. Numerous questions arose concerning the proper

method of computing the weight of canned products and tolerances and variations from the declared quantity of contents which might be considered reasonable within the meaning of the statute. The question of liquids surrounding the meat and products in cans was also given attention, resulting in the correction of the practice of including the weight of added water in the statement of quantity on containers. In the case of canned products packed for commercial use and found to bear incorrect statements of weight relabeling was required. Errors of this nature occurring on products prepared for the Army were called to the attention of the War Department and resulted either in the correction of the statements of weight or in the rejection of the products.

In cooperation with the War Industries Board and the Committee on the Conservation of Tin Plate of the Federal Food Administration the slack filling of tin containers of meat or meat food products at establishments under inspection was prohibited during the period of the war.

MEAT-INSPECTION LABORATORIES.

The laboratory examination of samples of meat and meat food products prepared at establishments at which inspection is conducted has been continued in the meat-inspection laboratories maintained in Washington and six other cities of the country. This examination consists in determining whether the product is properly labeled or contains any deleterious substance, in analyzing spices, waters, and other ingredients used in the curing and preparation of meat food products, and in analyzing rat exterminators, inks, etc.

The laboratories also continued to examine meat and products prepared for the Army and the Navy to determine whether they contained any harmful substance and to see that they conformed to the Army and Navy specifications.

The total number of products analyzed during the year was 60,040, of which 51,737 were domestic, 992 imported, and 7,311 specially prepared for military consumption. Samples of 1,491 domestic and 38 imported products were found to be not in accordance with the regulations and 21 of those examined for the Army and the Navy were rejected. Of 686 waters examined 111 were prohibited for use in their untreated state where they would come in direct contact with meats.

Four hundred and fifty gallons of branding ink was prepared and sent to meat-inspection stations for use in marking meats.

In addition to the routine work of a regulatory nature, the Washington meat-inspection laboratory has cooperated with the Office of Home Economics of the States Relations Service in studying the composition of undigested fats. Studies have been made also of fats which had been heated to the smoking temperature, the tests showing that such fats undergo a slight decomposition. The Washington laboratory developed a method for the detection of whale meat in sausage or other mixtures with animal fats. In cooperation with the Bureau of Markets, the Washington and St. Louis laboratories have made studies of the melting point and composition of the fat of soft pork. All creameries which prepare butter to be used in oleomargarin were inspected, and lists were issued showing those which met the requirements relative to pasteurization.

QUARANTINE DIVISION.

The work of the Quarantine Division, under Dr. R. W. Hickman, chief, has consisted, as heretofore, in the inspection and quarantine of imported live stock, the inspection of animals for export, the tuberculin testing of import and export dairy and breeding cattle, the inspection, disinfection, and fitting of ocean steamers which carry live stock, and the administration of regulations governing the importation of hides, hair, wool, hay, straw, etc.

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS.

Imports of live stock were seriously interfered with by the great difficulty in procuring steamer space and sailings during the first half of the fiscal year and also by the appearance of foot-and-mouth disease in England. Outbreaks of that disease in Sussex in September and in Yorkshire in January necessitated the closing of United States ports to European shipments until late in April. With the improvement of shipping conditions and the reopening of our ports to British shipments, American purchasers in England promptly made use of the opportunity for which they had been waiting, and live-stock importations for May and June indicated a return to the normal volume.

The following tables show the importations of the various kinds of live stock through the different ports of entry:

Imported animals inspected and quarantined.

Port of entry.	Cattle.	Sheep.	Swine.	Other animals.
New York.....	583	295	9	156
Boston.....	110			
San Francisco.....		128		94
Canadian border ports.....	1,878	618	152	44
Total.....	2,573	1,011	161	294

Imported animals inspected but not quarantined.

Port of entry.	Cattle.	Sheep.	Swine.	Goats.	Horses.	Other animals.
New York.....					71	
Baltimore.....					110	
Boston.....	110				1	
New Orleans.....					22	
Philadelphia.....						1
San Francisco.....						471
Key West.....				2	331	
San Juan.....	357					
Newport News.....					6	8
Mexican border ports.....	88,778	63,973	273	24,725	5,509	1
Canadian border ports.....	356,549	117,973	24,102	14	8,753	99
Total.....	445,791	181,946	24,375	24,741	14,806	580

Inspectors of the bureau also inspected and held in quarantine for the Bureau of Biological Survey 4,358 live quail imported from Mexico for breeding purposes.

The 357 cattle shown in the second table as entered at San Juan, Porto Rico, were shipped from the Virgin Islands and were not subject to the United States quarantine laws.

The animal quarantine station for the port of Baltimore, having been turned over to the War Department early in the preceding year for the storage of munitions and not yet relinquished, was unavailable for quarantine purposes throughout the entire year; hence all importations of animals subject to quarantine and coming to the Atlantic seaboard were entered at New York or Boston.

Through the courtesy of the British Government the bureau has continued to maintain an inspector in Great Britain, among whose duties is the tuberculin testing of cattle intended for shipment to the United States. During the year 786 cattle were so tested in the United Kingdom and the Channel Islands at the request of importers. This work is shown in the following table:

Results of tuberculin tests of cattle for importation into the United States.

Breed.	Tested.	Passed.	Rejected.
Ayrshire.....	2	2	.....
Guernsey.....	567	562	5
Hereford.....	2	1	1
Holstein.....	1	1	.....
Jersey.....	123	120	3
Northhorn.....	91	81	7
Total.....	786	770	16

Cattle not accompanied by satisfactory certificates of tuberculin test signed or approved by the bureau inspector in Great Britain must be tested in quarantine after arrival in the United States. Ninety-nine cattle were thus tested and all were passed.

IMPORTATIONS OF ANIMAL BY-PRODUCTS.

The bureau, through the Quarantine Division, has continued its cooperation with the Treasury Department in the administration of the regulations governing the sanitary handling and control of hides, skins, and other animal by-products offered for entry into the United States. This bureau endeavors to protect the domestic live stock from possible infection of anthrax, foot-and-mouth disease, and rinderpest, which diseases exist in many parts of the world from which animal by-products are imported. These regulations provide that hides and skins from countries where anthrax is prevalent, or in which foot-and-mouth disease or rinderpest exists, shall be disinfected prior to shipment, or, at the discretion of the shipper, any such hides and skins may be forwarded to the United States, subject to disinfection at a tannery at destination under bureau supervision. The greater part of the imported hides and skins are so certified as to render them eligible for importation without disinfection.

INSPECTION OF ANIMALS FOR EXPORT.

The exportation of live stock is subject to regulations providing for inspection to assure that the animals are in good health and for their humane handling and safe transport. All live stock offered

for export is inspected and in certain cases certificates are issued. Cattle for dairy and breeding purposes are subjected to the tuberculin test. Statistics of the inspection of animals for export are given in the following table:

Inspection of animals for export.

Kind of animals.	With certificate.		Without certificate.		Total.
	American animals.	Canadian animals. ¹	To Canada.	To other countries.	
Cattle.....	1,361	1	8,735	818	10,915
Sheep.....	8		5,155		5,163
Goats.....	9		18		27
Swine.....	696		98	602	1,396
Horses.....	² 9,775		5,441	234	15,450
Mules.....	³ 8,150		193	3	8,346
Total.....	19,999	1	19,640	1,657	41,297

¹ In former years considerable numbers of Canadian animals were exported through the United States. Although only one animal was so exported during the past fiscal year, this column is kept separate for comparison with previous statistics.

² Including 9,615 horses to Europe for military purposes.

³ Including 7,411 mules to Europe for military purposes.

Of the cattle inspected for shipment to Canada, 1,321 were dairy and breeding stock and were tested with tuberculin; 85 reacted and were rejected. The remaining 7,414 cattle for Canada were range animals and were not tested. The 818 cattle for other countries were tested with tuberculin; 10 reacted and were rejected. The mallein test was applied to the 5,441 horses and 193 mules for Canada and 234 horses and 3 mules for other countries, with only 2 reactors.

In carrying out the regulations governing the overseas transportation of live stock 215 inspections of vessels were made before clearance.

DAIRY AND BREEDING CATTE FOR BELGIUM AND FRANCE.

Since the close of the war an entirely new line of business is in course of development in connection with the exportation of live stock, namely, the shipment of dairy and breeding cattle to France and Belgium. Three small shipments had gone forward at the close of the year, one to France and two to Belgium, the former consisting of 135 head and the latter of 180 and 350, respectively.

FIELD INSPECTION DIVISION.

The Field Inspection Division, under Dr. A. W. Miller, chief, has continued its activities for the control and eradication of certain diseases of live stock and has also conducted work in the enforcement of certain live-stock quarantine and transportation laws.

ERADICATION OF SCABIES.

In the work of eradicating sheep scabies in cooperation with State officials bureau employees in the field made 22,394,561 inspections and supervised 10,518,196 dippings, constituting increases over the year before of 14 and 88.3 per cent, respectively. The bureau also assisted State authorities in arresting outbreaks of sheep scabies in Michigan and Iowa. In Michigan the eradication has been practically com-

pleted, while in Iowa, where the infection was widely scattered through the introduction of feeder sheep, progress is being made toward its elimination. No cases of the disease are now known to exist in Montana or North Dakota, and in Idaho the considerable spread of the infection following the outbreak of the previous year has been brought under control and the work of eradication in affected areas is progressing. The island of San Clemente, Calif., was quarantined on account of the prevalence of sheep scabies.

In the course of the cooperative eradication of cattle scabies bureau employees made 1,707,917 inspections and supervised 935,539 dippings of cattle in the field, the dippings marking an increase of 46 per cent over the figures for the preceding year. An extensive spread of the infection in western Kansas is being brought under control, and in the new areas of infection in southwestern New Mexico effective work is being done by bureau and State employees. In northwestern Texas and in Montana the disease was found to exist to a considerably greater extent than for several years.

Bureau employees also assisted State authorities in Colorado, Nebraska, and Vermont in efforts to eradicate sarcoptic mange in numerous herds of cattle in those States.

Horses and mules to the number of 414 were inspected for scabies and 74 were dipped under bureau supervision.

ERADICATION OF DOURINE.

Intensive efforts to control and eradicate dourine of horses were continued and satisfactory progress was made. In the Middle and Northwestern States, where the disease has prevailed, the extent of the infection was found to be considerably less than in former years. No cases are known to exist in Iowa or Nebraska, and the infection exists only to a slight extent in North Dakota and Wyoming. In South Dakota a large number of animals were tested and less than 1 per cent found to be affected. In Arizona and New Mexico, however, especially in the former, further investigations and the testing of large numbers of horses revealed the widespread existence of the disease. As the affected areas are largely within the various Indian reservations, and the horses, which are owned principally by the Indians living under a tribal form of government, are wild ponies ranging in rough and inaccessible regions, eradication work is carried on under great difficulties. However, officials of the States concerned and of the Indian Service of the Department of the Interior, as well as horsemen in the affected areas, have cooperated with the bureau in a satisfactory manner and considerable progress has been made. The bureau continued the practice of paying one-half of the appraised valuation of infected horses destroyed when they were owned by citizens, such share not to exceed \$100 in any one case. The number of animals tested and the results of the tests are reported by the Pathological Division.

INSPECTION OF ANIMALS FOR INDIAN AGENCIES.

In cooperation with the Office of Indian Affairs, 53 head of horses and mules and 40 head of cattle were inspected for allotment to Indian agencies. Twenty of the horses and mules were rejected, the remainder of the animals being passed for allotment.

CONTROL OF INFLUENZA, ANTHRAX, AND OTHER DISEASES.

In continuation of the war emergency campaign to stimulate the production and conservation of live stock, work was carried on looking to the control of anthrax, influenza, and other diseases and to a reduction of the losses resulting therefrom.

The assignment of 30 bureau employees to service with the War Department to assist in the efforts being made to reduce losses among Army horses and mules from influenza was continued until about February 1. The activities of these employees were directed toward bettering sanitary conditions at all points where public animals were handled, and great improvement was made, with the result that such losses were very materially reduced.

At the large markets of the country bureau employees were regularly assigned to work for the control of influenza, inspecting all horses and mules received and isolating sick animals. At those stations 507,559 such animals were inspected, of which 5,341 were sent to the hospital. Of the latter number 622 died of influenza, which showed a great reduction below the average losses of previous years. In addition to the regular assignments, cooperation was extended to State officials and horsemen at practically all bureau stations.

Cooperation was extended to the officials of various States, especially those along the Gulf coast, in the control of anthrax and the reduction of losses from that disease. Bureau employees supervised the disinfection of infected premises and the proper disposal of carcasses of animals dead from anthrax, and whenever necessary assisted the owners of infected herds in the vaccination of susceptible animals. In southern Texas alone, where the disease has existed extensively in recent years, bureau employees assisted in the vaccination of about 30,000 animals. Good results were obtained and the value of prompt and vigorous control measures was fully demonstrated.

On the request of stockmen or other interested persons, bureau employees were detailed to investigate outbreaks of blackleg, to advise owners as to the proper treatment, and, if necessary, to assist in vaccination.

Investigations of reported outbreaks of disease among domestic animals were made in various parts of the country. In cooperation with the State officials of South Dakota the bureau assisted in successfully arresting a serious outbreak of cerebrospinal meningitis among horses. Cooperation was also extended to the National Park service in determining the cause of the death of a number of buffaloes in Yellowstone Park.

To guard against the recurrence of foot-and-mouth disease, careful inspections of all ruminants and swine received at public stockyards were made by experienced veterinarians specially assigned to that work as in previous years. Prompt investigations were made of all suspected outbreaks of the disease reported to the bureau, with negative results in all instances.

LIVE-STOCK SANITARY WORK IN INTERSTATE COMMERCE.

In the course of supervising the interstate transportation of live stock to prevent the spread of animal diseases, bureau employees at market centers inspected 22,594,329 cattle, of which 10,897 were

dipped under bureau supervision in order that they might continue in interstate commerce. Sheep to the number of 20,597,232 were also inspected for communicable diseases, and of these 884,294 were dipped under bureau supervision to comply with the regulations of the department or of the States of destination.

An outstanding feature of this work during the year was the great increase in the number of swine immunized against hog cholera in order that they might be distributed from public stockyards for purposes other than slaughter. The number so immunized after careful inspection was 614,673, an increase of 140 per cent over the preceding year.

Upon request of transportation companies and shippers or to comply with laws of States to which shipments were destined, bureau veterinarians inspected 17,346 horses and mules, of which 5,854 were tested with mallein, 9 showing reactions.

During the year 24,655 cars carrying animals affected with communicable diseases were received at bureau stations. In compliance with department regulations or on request of Canadian Government officials, State officials, or transportation companies, 44,843 cars were cleaned and disinfected under bureau supervision.

VIOLETIONS OF LIVE-STOCK TRANSPORTATION AND QUARANTINE LAWS.

The bureau has continued to report to the Solicitor of the department, for presentation to the proper officials of other departments, cases of apparent violations of live-stock transportation and quarantine laws. Many of these cases have required special investigation on the part of bureau employees, such as interviewing witnesses and examining railroad and other records. Five bureau employees were regularly assigned to this work, though the greater part of the work of collecting evidence and preparing and submitting reports is done by bureau employees at stockyard centers, in connection with their other duties. The enforcement of the so-called 28-hour law has resulted in better facilities being provided for the feeding, watering, and handling of live stock in transit.

TICK ERADICATION DIVISION.

The work for the suppression of Texas or tick fever of cattle and the extermination of the ticks which transmit it has again shown greater progress than in any previous year. This work is conducted through the Tick Eradication Division, of which Dr. R. A. Ramsay is chief, in cooperation with the authorities of the Southern States affected.

PROGRESS IN TICK ERADICATION.

Areas aggregating 79,217 square miles, having been freed of ticks, were released from quarantine during the fiscal year. This action makes available 93 counties and 33 parts of counties into which better-bred cattle from tick-free States may be safely introduced, with consequent increase in beef and in dairy products. The total area released since the beginning of this work in 1906 amounts to 458,529 square miles, which is nearly 63 per cent of the originally infected area. The work is also far advanced in a large

additional territory. The following table shows the territory released during the past fiscal year:

Areas released from quarantine as a result of eradicating cattle ticks, fiscal year 1919.

State.	Square miles.	State.	Square miles.
Alabama.....	2,102	North Carolina.....	1,983
Arkansas.....	2,184	Oklahoma.....	8,749
Florida.....	4,745	South Carolina.....	8,619
Georgia.....	7,618	Texas.....	19,725
Louisiana.....	23,492	Total.....	79,217

During the year 47,843,791 inspections or dippings were made of cattle for the eradication of ticks as against 34,927,959 in the preceding year. There were in operation 33,789 cattle dipping vats where cattle were dipped under Federal or State supervision to rid them of ticks.

A great deal of advance work pertaining to the construction of dipping vats and preparing counties and localities for regulatory tick-eradication activities in the near future was conducted with a view to proper organization for taking up and carrying on the work in new areas. Effectual cooperation has come from many sources and interests.

Until 1916 what is known as the local-option system was followed in nearly all States cooperating in tick eradication. Under this plan the systematic dipping of cattle every 14 days (which is necessary for the extermination of the parasite) could not be begun in a county until after an election had been called and held and a majority of the voters in the county had expressed themselves in favor of driving out the ticks. This plan was found to work well up to a certain point. That point was when the remaining counties would not vote for tick eradication and became a menace to the tick-free counties which were being stocked with purebred cattle not immune to tick fever. Mississippi affords an example of how this condition was overcome. When 31 counties stood as an obstacle to further progress the farmers and live-stock men of the tick-free areas induced the legislature to enact a State-wide law requiring county officers within a certain time to provide dipping vats, dipping material, and men to supervise the dipping of all cattle every 14 days from April to November, inclusive, in 1917. The result was that the entire State was released from quarantine on December 1 of that year.

Observing the good results in Mississippi, Louisiana enacted similar legislation, which became effective April 1, 1918. Little opposition was met and such good work was accomplished that on December 1 of the same year 29 counties and parts of several other counties, in all an area of 23,492 square miles, were released from quarantine, and the work is so far advanced in all remaining quarantined areas that their early release seems assured.

Texas also has enacted a State-wide law, but because of the size of the State and the large tick-infested area a different plan has been

adopted. The law divides the State into three zones and became effective January 1, 1919, in zone 1, which includes about 65 counties in the northeastern part of the State.

In Alabama there remained 24 counties which during the past two or three years on one or more occasions had refused to vote for tick eradication. The legislature enacted a State-wide law for compulsory dipping, effective March 7, 1919. The regular dipping of cattle was taken up in all the counties, and the State is approaching complete release.

The Georgia legislature enacted a State-wide law to become effective in December, 1919, and arrangements are now being made to enforce it.

Experience has proved that the principle of county or local option on the question of tick eradication is a good way of beginning the work in a State, but that eradication can be more quickly completed by the application of a State-wide law requiring all the tardy counties to take action at the same time in order that the ticks may not be permitted to remain in a few counties or localities and endanger the cattle industry in the areas already freed.

SHIPMENTS FROM QUARANTINED AREAS.

The number of cattle of the quarantined area shipped to market centers for immediate slaughter was 4,807,865, which is a considerable increase over the preceding year and was brought about by local conditions such as drought, which required the immediate marketing of many cattle. Moreover, many cattle owners in tick-eradication localities have shown a disposition to ship for slaughter as many unprofitable cattle as possible in preference to dipping them. This was done with a view of producing, after ticks were eradicated, better-bred animals likely to be more profitable for breeding purposes. "Dipped ticky cattle" to the number of 8,361 were shipped to points where inspection is provided and dipping facilities maintained, for further treatment for movement as noninfectious. At public stockyards 85,087 cattle were dipped and certified for movement as noninfected. For these shipments 1,673 certificates were issued.

At points other than public stockyards 89,616 cattle were inspected or dipped and certified for interstate movement as noninfected, as provided for in the regulations. To cover the shipments of these cattle 979 certificates were issued.

TUBERCULOSIS ERADICATION DIVISION.

The work of the Tuberculosis Eradication Division, in charge of Dr. J. A. Kiernan, chief, for the control and eradication of tuberculosis of live stock, has been extended to include active cooperation with 43 States. The live-stock sanitary officials of these States are extending all possible cooperation. States not cooperating with the department are in most instances unable to do so because of unsuitable laws or lack of funds. Cattle owners throughout the country, including those in States not doing cooperative work, are becoming more and more interested. The plan of accrediting tuberculosis-free herds of cattle and the law under which indemnity may be paid for

reacting animals have been of great value in advancing the campaign. For carrying on its field work for the eradication of tuberculosis the bureau has offices in 33 cities in as many States, an increase of 10 during the fiscal year.

TESTING CATTLE FOR TUBERCULOSIS.

Under the supervision of bureau officers there were tested with tuberculin 329,878 cattle, of which 13,528, or 4.09 per cent, reacted. A summary by States is given in the accompanying table.

Summary of tuberculin testing of cattle in cooperative tuberculosis-eradication work.

States.	Cattle tested.	Cattle reacted.	Percent reacted.	States.	Cattle tested.	Cattle reacted.	Percent reacted.
Alabama.....	17,446	226	1.29	Nevada.....	479	18	3.75
Arkansas.....	495	10	2.02	New Hampshire.....	789	41	5.19
Colorado.....	976	25	2.56	New Jersey.....	2,789	255	9.14
Connecticut.....	1,917	141	7.35	New Mexico.....	48		
Delaware.....	602	31	5.14	New York.....	7,211	482	6.68
District of Columbia.....	1,264	8	.63	North Carolina.....	6,972	118	1.71
Florida.....	7,193	375	5.12	North Dakota.....	14,052	485	3.45
Georgia.....	9,858	265	2.67	Ohio.....	11,156	740	6.63
Idaho.....	1,033	14	1.34	Oklahoma.....	1,525	147	9.60
Illinois.....	10,247	872	8.50	Oregon.....	4,483	111	2.47
Indiana.....	7,001	211	3.01	Pennsylvania.....	8,323	412	4.61
Iowa.....	6,689	361	5.38	Rhode Island.....	424	79	1.86
Kansas.....	7,502	362	4.82	South Carolina.....	5,086	152	2.98
Kentucky.....	6,729	216	3.06	South Dakota.....	5,885	427	7.25
Louisiana.....	9,849	386	3.91	Tennessee.....	10,923	231	2.11
Maine.....	7,609	175	2.29	Utah.....	4,762	82	.17
Maryland.....	8,265	763	9.23	Vermont.....	14,684	1,146	7.79
Massachusetts.....	2,994	164	5.47	Virginia.....	19,561	562	2.87
Michigan.....	8,352	289	3.46	Washington.....	8,466	209	2.46
Minnesota.....	32,642	1,399	4.27	West Virginia.....	1,393	57	4.09
Mississippi.....	10,087	82	.81	Wisconsin.....	15,554	579	3.72
Missouri.....	1,232	69	5.60	Wyoming.....	3,704	16	.43
Montana.....	17,607	493	2.80				
Nebraska.....	4,014	242	6.02	Total.....	329,878	13,528	4.09

The District of Columbia gives an illustration of what may be accomplished during a term of years by the systematic testing of cattle for tuberculosis and properly disposing of reactors. Work of this kind has been under way in the District for 10 years. At the beginning of this period the tuberculin test showed that 19 per cent of the cattle were tuberculous. During the past fiscal year 1,264 cattle in the District were tested and only 8 reactors obtained, a percentage of 0.63. Three hundred and seventy cattle in interstate movement were also tested for admittance into the District of Columbia, and of this number 30, or about 8 per cent, were found to be infected with tuberculosis.

INSPECTION AND TESTING FOR INTERSTATE MOVEMENT.

During the year there were inspected by bureau veterinarians, in compliance with the laws of the States to which the animals were destined, 41,609 cattle moved interstate for purposes other than immediate slaughter, of which 40,586 were tested with tuberculin. Of the number tested 1,182 reacted.

ACCREDITED TUBERCULOSIS-FREE HERDS.

The movement to establish and maintain a list of herds of purebred cattle officially accredited as being free from tuberculosis has met with wide favor among herd owners and is spreading rapidly. The plan, in brief, is to test the cattle with tuberculin at the request of the owner, to eliminate any reacting animals either by slaughter or by following prescribed sanitary measures, to repeat the test at prescribed intervals, and to list as tuberculosis-free accredited herds all herds entitled to that distinction. Official certificates are issued to the owners of such herds. Two lists of accredited herds have been compiled and printed. Up to April 1, 1919, a total of 782 herds, containing 12,082 purebred and 6,939 grade animals had been fully accredited, and 6,535 herds comprising 39,558 purebred and 57,685 grade animals had been listed as having passed one test.

CATTLE SLAUGHTERED AND INDEMNITY PAID.

October 1, 1918, funds became available to the bureau for the payment of indemnity for tuberculous animals slaughtered in the work of eradication. Indemnity was paid partly by States and partly by the Federal Government. The accompanying table gives statistics of cattle slaughtered, appraisal, indemnity, salvage, etc.

Cattle slaughtered, appraised value, indemnity allowed, and salvage realized in work of tuberculosis eradication, October 1, 1918, to June 30, 1919.

State.	Number of cattle.	Average appraisal per head.	Total State indemnity.	Total Federal indemnity.	Average State indemnity per head.	Average Federal indemnity per head.	Average salvage per head.
District of Columbia....	7	\$100.00	.....	\$135.00	.....	\$19.29	\$39.64
Idaho.....	5	160.00	\$129.66	129.66	\$25.93	25.93	23.85
Indiana.....	28	184.82	1,155.86	966.77	41.28	34.52	59.15
Iowa.....	1	167.00	34.00	25.00	24.00	25.00	65.00
Kansas.....	252	270.33	19,617.41	10,145.50	77.85	40.26	73.31
Kentucky.....	176	202.20	15,678.79	5,589.72	89.08	31.76	30.39
Maine.....	91	114.84	3,751.46	2,025.60	41.22	22.26	25.30
Maryland.....	502	90.72	7,713.82	7,713.84	15.37	15.37	47.14
Michigan.....	100	245.80	9,255.00	4,475.43	92.55	44.75	79.58
Minnesota.....	728	94.85	25,142.09	8,626.59	34.54	11.85	46.98
Missouri.....	18	198.61	551.54	547.53	30.64	30.42	72.31
Montana.....	83	83.00	4,750.13	1,604.60	57.23	19.33	20.06
Nebraska.....	73	299.18	3,099.87	3,097.87	42.46	42.43	64.15
Nevada.....	15	130.66	681.36	358.11	45.42	23.87	27.56
North Carolina.....	38	188.29	1,075.98	1,075.98	28.32	28.32	60.80
North Dakota.....	37	59.46	1,323.52	662.39	35.77	17.90	10.11
Ohio.....	203	147.17	12,323.53	4,820.79	60.70	23.75	57.89
Oklahoma.....	4	300.00	459.24	200.00	114.81	50.00	70.39
Oregon.....	7	149.35	312.50	260.34	44.64	37.19	37.78
Pennsylvania.....	120	153.96	5,137.15	3,515.69	42.81	29.30	40.55
Rhode Island.....	6	250.00	181.83	168.83	30.31	28.14	42.60
South Carolina.....	22	97.50	480.59	480.59	21.85	21.85	31.97
South Dakota.....	193	168.16	7,223.14	4,943.71	37.43	25.62	43.42
Utah.....	34	102.06	663.33	663.33	19.51	19.51	41.18
Vermont.....	829	75.74	32,325.81	14,736.46	38.99	17.78	19.32
Virginia.....	11	350.00	293.91	293.91	26.72	26.72	53.48
Washington.....	49	99.93	1,024.73	689.73	20.91	20.20	26.27
West Virginia.....	10	120.00	522.48	238.80	52.25	23.88	42.21
Wisconsin.....	2	200.00	50.68	50.68	25.34	25.34	74.66
Total.....	3,644	127.82	154,959.39	78,542.45	49.92	21.94	41.49

DIVISION OF HOG-CHOLERA CONTROL.

The Office of Hog-Cholera Control was made a division in April, 1919, and Dr. U. G. Houck was appointed chief of the division to fill the vacancy created by the resignation of Dr. O. B. Hess.

COOPERATIVE WORK FOR CONTROL OF HOG CHOLERA.

The work for the control and suppression of hog cholera progressed along the lines of the preceding year, in cooperation with the regulatory authorities and the extension divisions of agricultural colleges in 34 States where hog raising forms an important part of the farming activities. For a time as many as 180 bureau veterinarians were assigned to hog-cholera control work, but the average for the year was about 135.

Through the increase of the field force, which was made possible by the increase of funds from the war emergency appropriation, the swine industry received more protection against losses from hog cholera than ever before. Notwithstanding an increase of over 4,000,000 above the number of hogs in the preceding year as a result of efforts to stimulate production, besides the abnormal conditions that prevailed as a consequence of the war, the mortality of swine from all diseases showed a slight decline, from 42.1 per 1,000 in 1918 to 41.4 per 1,000 in 1919, or about 37 per 1,000 from hog cholera. This is the lowest point recorded in 36 years.

Hogs shipped from public stockyards into the various States for feeding purposes were kept under observation at destinations for a time to observe the results of the hog-cholera preventive treatment administered at the yards before shipment. The observation of these animals added materially to the duties of both bureau and State inspectors, as 614,673 feeder hogs were immunized at public stockyards and shipped, which was a great increase over any previous year.

Many garbage-feeding stations in the vicinity of large cities and military and naval camps were kept under observation, as such places are always liable to become centers of infection.

SUMMARY OF ACTIVITIES.

During the year 12,336 outbreaks of hog cholera were reported to the bureau inspectors by county agents, live-stock owners, and others. These outbreaks were investigated in cooperation with the State authorities. Under the direction of those authorities 9,564 farms were quarantined on account of outbreaks of the disease, and 4,382 were cleaned and disinfected. A total of 51,022 farm investigations were made on infected and adjacent premises, and 53,586 post-mortems were held to determine the nature of the disease that existed among the animals on the farms visited by the inspector.

Literature on the subject of hog cholera was widely distributed, and 2,734 meetings were held in hog-raising districts for the purpose of forming organizations and giving information and instructions to live-stock owners concerning quarantine, sanitation, and the serum treatment as successful means for preventing losses from hog cholera. These meetings were attended by 78,584 farmers and others. In

addition, the inspectors held personal interviews with 315,359 live-stock owners, veterinarians, county agents, bankers, and others.

In all, 93,512 farms were visited by the bureau inspectors, at the request of the owners or otherwise, to observe the condition of live stock and to give advice and other assistance.

To demonstrate to veterinary practitioners and others the proper technique in administering the protective serum treatment, 233,987 hogs were treated.

Veterinary practitioners and others trained to administer the hog-cholera preventive treatment, and working in cooperation with the bureau forces, reported the treating of 5,474,685 hogs in the 34 States where bureau veterinarians are stationed. Since it is estimated that less than 50 per cent of the hogs treated are reported to the State and bureau authorities, it is conservatively estimated that the treatment was administered to more than 12,000,000 hogs in the United States during the year. A notable effect of the year's work during the past year has been the great increase in the use of serum by hog owners.

PATHOLOGICAL DIVISION.

The scientific investigation of animal diseases has been, as heretofore, the principal work of the Pathological Division, under the direction of Dr. John S. Buckley, chief. In addition, the division has studied the poisoning of live stock by plants, has aided in the supervision of viruses, serums, and other stock remedies, and has carried on certain routine work relating to diseases of animals.

INFECTIOUS ABORTION.

The study of infectious abortion has been continued in an effort to acquire further information that may be advantageously utilized in combating this serious malady. The manner in which the disease is introduced into abortion-free herds is regarded as sufficiently well understood to enable stock owners and dairymen by practicing reasonable precautions to keep healthy herds clean; but the control and elimination of the infection after it has made its appearance continues to be a perplexing problem.

Increased interest has more recently been manifested in methods of artificial immunization as a result of experiments conducted by English investigators where promising results followed the employment of a living abortion-organism vaccine administered shortly before the animals were bred. A considerable amount of experimental work has been conducted along similar lines during the last two years. When a limited number of susceptible animals were utilized in an experimental capacity the results strongly indicated that protection could be conferred, but when the same method was applied to upward of 600 animals in an infected herd only a very slight reduction in abortion losses was accomplished. Results have indicated that only susceptible animals derive possible benefit from the method, no decrease in losses having resulted from the treatment of animals giving positive reactions. While the results obtained under experimental and herd conditions were somewhat contradictory, sufficient evidence that immunity was conferred in some instances was obtained to justify further immunizing investigations.

Additional evidence was obtained that bulls giving positive reactions to the abortion tests may harbor abortion infection in their generative organs and that the presence of the infection may be associated with definite lesions. The findings in five cases are described in a paper appearing in the *Journal of Agricultural Research*.

While abortion disease up to the present time appears to have interfered to only a slight extent with the swine industry, further evidence has been obtained that abortion infection is capable of causing losses in some instances in hogs. The presence of the infection was definitely established in one outbreak in Indiana, and on six other farms in the same State where abortion losses had been heavy among sows abortion infection was indicated by positive agglutination reactions.

Serological tests have been applied to several hundred samples of blood serum from suspected cases, and the definite knowledge thus gained as to the presence of the disease in many cases has enabled cattle owners to adopt appropriate control measures.

Cooperative research work by investigators at the veterinary department of Cornell University, in connection with an outbreak of disease in a flock of 235 Merino ewes where 50 per cent or more aborted or produced immature lambs, disclosed as the probable causative factor a spirillum, a type of microorganism not hitherto recognized in this country as associated with ovine abortion, although a similar type of organism had been previously isolated from aborting cows in this division. Severe abortion losses in sheep in Great Britain have been attributed to a similar if not identical type of infection. The losses from ovine abortion in this country up to the present time have been slight.

BACILLUS X AND EQUINE INFLUENZA.

An organism morphologically and culturally closely resembling *Bacillus subtilis*, and designated as Bacillus X by its discoverer, has been incriminated as a factor in the cause of equine influenza, and studies have been made of that organism in relation to the disease. Results of investigation show that no serological relationship exists between Bacillus X and *B. subtilis*. Large doses of Bacillus X failed to produce any evidence of disease when injected into guinea pigs, rabbits, or horses. Agglutinins and specific complement-fixing bodies are demonstrable in hyperimmune serum.

In a test for toxin production, horses were temporarily discomforted by large injections of sterile bouillon filtrates of this organism, after which the animals remained normal. Guinea pigs and rabbits showed no ill effects from injections of this filtrate. The filtrate showed distinct antigenic properties when used as an antigen against serum from horses hyperimmunized against Bacillus X.

Complement-fixation tests with Bacillus X as an antigen, on a limited number of serums for animals affected with influenza or recently recovered from that disease, resulted in negative reactions in all cases. Several of these serums in low dilutions showed some agglutinating power against Bacillus X suspension. This same agglutination was also evidenced in certain normal horse serums in which exposure to influenza infection could be reasonably excluded.

DOURINE INVESTIGATIONS.

The complement-fixation test has continued to be extensively employed for the diagnosis of dourine of horses, 46,819 samples of serum having been tested, of which 1,143, or 2.4 per cent, gave positive reactions.

Experiments are being made on drying trypanosome suspensions for the purpose of preparing permanent dourine antigens of unvarying titer. Out of three lots of trypanosomes dried, one retained its antigenic value for one year at low temperature and in vacuum, but lost all antigenic value after three months' exposure to room temperature and air.

OTHER RESEARCH WORK.

In cooperation with the Bureau of Chemistry, experimental studies were made with a strain of *Bacillus botulinus* isolated from home-canned asparagus. As an antitoxic serum effective against a strain of the bacillus isolated from cheese afforded no protection to animals injected with toxin from the asparagus strain, experiments are being made for the production of what is known as a polyvalent serum against botulism.

Bacteriological and biochemical studies of conditions in culture media and living tissue which favor the development of toxins and aggressions by the blackleg bacillus are in progress.

Seven cases of spontaneous tumors in white mice were examined, and from this material experiments in the transplantation of tumor particles and the breeding of mice have been undertaken in cooperation with the Biochemic Division with the object of further research work on tumors.

A series of experiments with butter-coloring matters including Jersey yellow, Sudan diazo-amido-benzine, etc., was undertaken in cooperation with the Bureau of Chemistry, to observe the effect on the skin. Microscopic studies were made of the cutaneous structures of experimental animals. The results proved the irritant action on the peripheral as well as the deeper parts of the skin.

Eleven samples of animal tissue and stomach contents were examined for poisons. In three tissues from a smelter region, zinc was found in two and lead and zinc in the third.

EXAMINATIONS FOR TUBERCULOSIS.

Specimen tissues from 176 cattle that had reacted to the tuberculin test but in which no visible tuberculosis growths had been found on ordinary post-mortem examination, were referred to the Pathological Division for final diagnosis. Tubercle bacilli were demonstrated in 85 cases, while none could be found in the specimens from the remaining 91.

GLANDERS.

Cooperative work for the control of glanders in various States was continued. The complement-fixation test was applied to 695 samples of serum forwarded by various State officials and practicing veterinarians; 174 of these samples gave positive reactions to the test, a per cent of 24.8.

RABIES.

Specimens submitted for examination for rabies came principally from Maryland, Virginia, West Virginia, Tennessee, and the District of Columbia. The number of cases in the District has perceptibly diminished. Of 117 suspected cases a positive diagnosis was made in 75, and in one case the material was so decomposed that no diagnosis was possible. The positive cases were 69 dogs, 1 cat, 4 cattle, and 1 sheep. A considerable number of persons, as well as a number of animals, had been bitten by the affected animals. In every instance, in which a person had been bitten, animal inoculation was made when the microscopic findings were negative.

BLACKLEG VACCINE.

Vaccine for immunizing cattle against blackleg is still in great demand. During the year, 3,339,815 doses were distributed free of charge to stock owners. The powdered form of vaccine that has been prepared by the bureau for many years is the only form distributed. Filtrates and aggressins, which many stockmen find very satisfactory in the immunization of their calves against blackleg, are being submitted to very careful tests to see that they possess the required protective qualities.

EXAMINATION OF BIOLOGICAL PRODUCTS.

Cooperating with the Office of Virus-Serum Control, which conducts the regulatory work in connection with the supervision of veterinary biological products under the virus-serum-toxin law, the Pathological Division has continued to carry out the testing of certain products. During the year there were submitted for examination 139 samples representing 30 different kinds of serums, bacterins, vaccines, and germ-free filtrates. Forty-two of these, or 30 per cent, were rejected for reasons such as contamination with foreign organisms or their products, insufficient attenuation of bacteria used in vaccines, and lack of potency. Three hundred and thirty-seven cultures of organisms intended for use in the manufacture of biological products were also examined, of which 72, or 21 per cent, were rejected because of contaminations and atypical cultural characteristics. The division also furnished to biological houses from its stock cultures many organisms of various types to be used in the manufacture of their products. The suggestions made to the various firms relative to their products, together with the report of the division findings in each instance, have served to induce greater accuracy in identifying cultures and testing their products, as it is exceedingly rare to find a second sample unsatisfactory to test. The effect of such work is to exclude from the market unsuitable and impotent products and in some instances products that are even dangerous to the live-stock industry.

POULTRY DISEASES.

Extensive outbreaks of a highly infectious disease of poultry were reported from some of the Eastern States. Carcasses of fowls submitted to the laboratory for examination were found to be affected with fowl typhoid, a disease quite similar to fowl cholera, though caused by a different microorganism. In severe outbreaks it is

almost as destructive as cholera. Information as to methods for control were given through bulletins and correspondence.

Avian material forwarded to the laboratory for diagnosis showed a variety of diseased conditions, the more important of which were white diarrhea of chicks, diphtheria and chicken pox, enterohepatitis or blackhead of turkeys, avian tuberculosis, and coccidiosis. Experiments were conducted to determine the relationship of coccidiosis of fowls and cattle. Fowls fed on material containing coccidia from cattle failed to develop coccidiosis.

AUTOPSIES ON WILD ANIMALS.

During the year 80 specimens of wild animals were received from the National Zoological Park (D. C.) for post-mortem examination. Of 45 birds examined there were 12 cases of enteritis, 2 of septicemia, 1 of peritonitis, 1 of sarcomatosis, 1 of parasitism, 1 of anemia, 1 of ptomaine poisoning, 2 of hemorrhage, 13 of tuberculosis, 3 of aspergillosis, 1 of cecal necrosis, and 7 undetermined. Of 35 mammals there were 5 cases of pneumonia, 1 of bronchopneumonia, 1 of pleurisy, 3 of enteritis, 2 of gastroenteritis, 4 of septicemia, 1 of peritonitis, 2 of tumors (adenomata sarcoma), 1 of parasitism, 3 of anemia, 1 of septic metritis, 7 of tuberculosis, 1 of prolapse of rectum, and 3 destroyed as unfit for exhibition (1 paraplegia, 1 extensive local infection of intermaxillary region, 1 severely injured).

PLANT POISONING OF STOCK.

In the investigation of poisonous plants nearly all the field experimental work has been conducted at the experiment station near Salina, Utah (provided by cooperation of the Forest Service), while most of the laboratory work has been done at Washington. The Bureau of Plant Industry has cooperated in the study of the plants. Its representative not only identifies the plants studied but carries on field investigations on their distribution and habits.

The work of chemical investigation of plants, begun in the preceding year, was considerably extended and advanced. More extended work was done also on the pathology of the diseased animals, and this has added to the knowledge concerning the effects of the poisonous principles.

A large number of plants have been under investigation. Special attention was paid to the "whorled milkweed" (*Asclepias galioides*), which occasions extremely heavy losses of domestic animals in Colorado and adjoining States, and a bulletin on this plant has been prepared for publication. Further work was conducted on the sneezeweed (*Dugaldia hoopesii*), and additions were made to the number of known loco plants. An investigation was also made of a plant growing in the Southern States, *Daubentonia longifolia*, which seems to be an important sheep-poisoning plant in Texas.

Among publications of the year was Department Bulletin 575, "Stock-Poisoning Plants of the Range," a popular treatise, with colored illustrations, intended to aid stockmen in recognizing and identifying such plants.

BRANCH LABORATORIES.

The branch pathological laboratories at Chicago, Omaha, and Denver have continued their work, which consists principally in making diagnoses of obscure cases arising in the meat inspection.

The Chicago laboratory also collected and examined a number of samples of water from various meat-packing establishments, made a report upon the existence of the avian type of tuberculosis in swine, and conducted some experiments with reference to the transmissibility of so-called hyperplasia of the bone marrow in cattle.

The Omaha laboratory received and examined 308 specimens representing the usual variety of routine diagnoses. Examinations for tuberculosis and hemorrhagic septicemia have increased, the former due to cases of slaughter following reaction to the tuberculin test. The similarity of lesions found in cases of certain affections of swine to lesions of hog cholera made diagnosis sometimes difficult.

Investigations pertaining to abortion disease have been made by the branch laboratory at Ithaca, N. Y.

BIOCHEMIC DIVISION.

The work of the Biochemic Division, under Dr. M. Dorset, chief, comprised chiefly, as before, investigations concerning hog cholera, laboratory research work relative to meat products, studies of dips and disinfectants, and the preparation of tuberculin and mallein.

HOG-CHOLERA INVESTIGATIONS.

The investigative work on hog cholera has been continued under three general heads: (1) Methods of producing immunity, (2) modes of spread of the disease, and (3) the causes of hog cholera and related diseases.

METHODS OF PRODUCING IMMUNITY AGAINST HOG CHOLERA.

Some additional work has been done with methods for refining old hog-cholera serum (defibrinated blood). The method referred to in last year's report, consisting in the addition to old serum of strong solutions of sodium chlorid, followed by heat with aeration, has been used further and found apparently satisfactory. It has been found also that the use of strong solutions of sodium chlorid may be dispensed with when the serum is diluted with several volumes of 1 per cent salt solution, containing a sufficient amount of phenol to produce a concentration of one-half of 1 per cent in the final mixture. This diluted serum is heated and aerated as in the other method. It has been found possible by this process, which includes filtration and precipitation of the globulins and antibodies, to refine and concentrate old defibrinated-blood antitoxin.

A further study of the effect of phenol (0.5 per cent) on the tuberculosis bacillus has indicated that the phenol alone can not be depended upon to destroy that organism in clear serum or in defibrinated blood, though it appears, after prolonged contact, either to attenuate the bacilli or to reduce the numbers very materially.

As a means of overcoming difficulty experienced by commercial firms in effectively maintaining proper temperatures in heating serum, the division has devised a method which makes it possible to heat serum at a definite temperature for any desired period of time without the use of the thermoregulator customarily employed. This is accomplished by the use of a double-jacketed kettle, the outer

jacket of which contains a liquid which boils at a temperature exactly sufficient to maintain the desired degree of heat in the serum itself.

Some progress has been made in the study of the duration of immunity in suckling pigs. One hundred and thirty-nine pigs given the simultaneous inoculation when very young (less than 3 weeks, some of them but 1 week old) were exposed to hog cholera by the injection of virus six months after simultaneous inoculation. Three of them died, but it was not possible to establish that even they died of hog cholera.

Experiments by the division have shown that the condition of the immune hogs which serve as serum producers is of prime importance in the production of potent serum. The influence which the time elapsing between immunization and hyperimmunization might exert upon the potency of the serum produced was studied and at the same time studies were made of diluted and laked virus blood as hyperimmunizing agents. The experiments show that hogs which are hyperimmunized within a short interval after a simultaneous inoculation do not produce serum of satisfactory potency; also that as a rule the ability of hyperimmunized hogs to yield potent serums increases within certain limits as the interval between immunization and hyperimmunization increases. The conclusion was therefore reached that an interval of not less than seven weeks should be allowed to elapse between immunization and hyperimmunization, and that the most uniformly satisfactory results will be obtained by allowing at least three months. The ability of immune hogs to respond to hyperimmunization to the desired degree, once acquired, remains unimpaired for at least a year. It was found also that simultaneous inoculation of nonimmune pigs with serum and virus is followed almost immediately by a remarkably firm immunity, so that they are able to withstand enormous doses of virus blood within a day or two after simultaneous inoculation; hence there is no evidence of a state of a hypersusceptibility to hog cholera following simultaneous inoculation. Diluted and laked virus blood was found not to possess any advantages over the undiluted blood. A full report of this work has been published in the *Journal of the American Veterinary Medical Association* (vol. 8, n. s., p. 259).

MODES OF SPREAD OF HOG CHOLERA.

Studies of the relation of insects to the spread of hog cholera have been continued. Studies of the hog louse (*Hematopinus suis*) have indicated that this parasite is incapable, under ordinary conditions, of transmitting the virus of hog cholera. Most of the work during the year related to the spread of hog cholera by means of flies, the common house fly (*Musca domestica*) being used as a representative of the nonbiting fly, and the stable fly (*Stomoxys calcitrans*) as a representative of the biting fly. Both species are commonly found about hog pens, and both are capable of traveling considerable distances. It was learned that individual house flies which feed upon the eye secretions or blood of sick pigs may harbor the virus of hog cholera for some days at least, and may convey the disease to healthy pigs by feeding on their eyes or on fresh wounds on their skins; yet

other experiments with nonimmune pigs which were placed in screened pens in which infected house flies were liberated in considerable numbers, without the production of a single case of infection, leave a very grave doubt as to whether under natural conditions the house fly is concerned in the dissemination of hog cholera. Likewise it was demonstrated that it is possible for the stable fly to convey infection, either by feeding upon the ears of infected pigs and then biting nonimmune pigs, or by becoming gorged with the blood of sick pigs and then being killed and placed in the feeding trough of nonimmune pigs; but it yet remains to be determined whether this insect is a factor of practical importance in the spread of the disease. Attempts were made to transmit hog cholera by means of mosquitoes, but the experiments were unsuccessful. A summary of a large part of these investigations was published in the Twenty-Second Annual Report of the United States Live Stock Sanitary Association, page 164.

In continuation of work reported last year, four experiments were made under farm conditions in the vicinity of Ames, Iowa, to determine how long the virus of hog cholera persists in pens after the removal of sick pigs. On four farms where hog cholera existed all hogs were removed and susceptible pigs were placed in the vacated lots after intervals of 24 hours, 48 hours, 7 days, and 10 days, respectively. In the first case, 1 of the 6 susceptible pigs sickened on the eighth day following exposure and communicated the disease to the others. In the 48-hour and 10-day experiments all the susceptible pigs remained well. In the 7-day experiment 1 sickened and died, though it could not be determined definitely whether it had contracted cholera, while the other 5 remained well. These experiments are merely the beginning of a line of work which seems to be of practical importance and which it is planned to continue as opportunity is found.

CAUSE OF HOG CHOLERA AND RELATED DISEASES.

In the fall of 1918 investigations of diseases related to hog cholera and resembling it were begun. An infection of this character appeared on a farm near Ames, Iowa, among shoats which had previously been given the simultaneous inoculation against hog cholera. The animals presented many of the symptoms commonly seen in cases of hog cholera, but investigation proved that it was a different disease, as hogs which were firmly immune against hog cholera contracted the other disease when exposed in the infected lots. The main characteristics of the disease were an inflammation of the large intestines, which showed on dissection a superficial layer of necrosis on the mucous surface, while beneath this there was a zone in which hemorrhage was more or less marked. The condition thus observed was no doubt what has been commonly termed necrotic enteritis. Microscopic examination revealed in the zone beneath the necrotic area typical threads of *Bacillus necrophorus*. Rabbits inoculated with bits of the diseased intestine developed typical necrophorus infection. The disease seems to be increasing in prevalence in certain of the Western States, and further efforts are being made to discover its cause and means of prevention.

DIPS AND DISINFECTANTS.

The laboratory of dips and disinfectants received for examination 131 samples of stock dips, disinfectants, and miscellaneous materials.

During the calendar year, 1918, there were sent to inspectors in the field 804 test outfits for arsenical dips and sufficient supplies for making 584,500 tests; 9 test outfits for lime-sulphur dips and supplies sufficient to make 3,200 tests; 13 test outfits for nicotin dips and supplies sufficient for making 2,970 tests. There were thus provided a total of 826 new testing outfits together with supplies sufficient to make a total of 590,670 tests.

In research work a comparison was made of the relative advantages of arsenious oxid and iodine, both of high purity, as standard substances in iodimetry. The results were published in the *Journal of the American Chemical Society* (vol. 41, p. 351).

Considerable work has also been done on a study of methods for evolving gaseous formaldehyde for disinfecting purposes, and it appears that less expensive methods than the potassium permanganate method will be found appropriate. This work is being continued.

Of the various substances used in dipping animals the compound cresol solutions are the only ones for which no suitable field test is available. The field test, which affords a means by which the inspector in the field may assure himself that the dipping bath after completion is of the proper strength, is considered highly important in carrying on field dipping operations successfully. For that reason considerable study has been given to the development of a method for testing cresol solutions in the field. A method of field testing has been devised which appears to be sufficiently promising to warrant an early trial of it in the field.

The laboratory has also carried on experiments to find a substitute for linseed oil, which is now scarce and high priced, and which has been required heretofore in the preparation of compound solution of cresol and of saponified cresol solutions. It has been determined that soy-bean oil, or the fatty acids derived therefrom, are well adapted for the purpose and may be used at a considerable saving in cost.

Some additional work has been done upon problems relating to the disinfection of hides and of tannery effluents, relating particularly to the effect of heat and of chlorine upon anthrax spores in the effluent from soak vats. The results obtained do not differ materially from those heretofore reported.

A comparative study has been made of the germicidal value of Dakin's solution, eusol, chloramine T, and chlorine in aqueous solution. This work indicates that these different disinfectants vary in their action upon different microorganisms. A study has been made also to determine the effect of lime upon the germicidal efficiency of phenol and cresol. Lime seems to lower distinctly the germicidal value of both of these disinfectants.

RESEARCH WORK ON MEATS AND MEAT PRODUCTS.

The nature of the research work on meats was changed in order to meet war conditions, and investigations that had been undertaken with a view to the conservation of materials used in the curing of

meats were continued and completed. It was established that high-grade meat can be cured as well in sterilized old pickle, properly strengthened, as in new pickle. It is entirely practicable, therefore, instead of discarding pickling solutions after use, to clarify, sterilize, and strengthen them and then use them again, with a considerable saving in the ingredients. Examinations showed that pickle after use still contained approximately, from 52 to 67 per cent of the original content of salt, from 44 to 74 per cent of the sugar, and from 41 to 80 per cent of the sodium nitrate.

An attempt was made to determine whether the entire quantity of sucrose (cane or beet sugar) used in curing meats could be replaced by some other sugar, so as to release the cane and beet sugar for general household purposes. Inquiry developed that there is generally an ample supply of substitutes for granulated sugar in the form of (1) "refiners' sirup," a by-product resulting during the manufacture of granulated sugar, and (2) corn sugar or dextrose, which is produced in several different grades. Practical curing experiments with meats in which several grades of corn sugar and refiners' sirup were compared with granulated sugar (sucrose) were carried out in four different meat-packing establishments. Nineteen tierces of hams, 19 tierces of sweet-pickled bellies, 9 boxes of fancy breakfast bacons, and 10 tierces of beef hams were cured. In these experiments several commercial grades of corn sugar or dextrose gave as good results as granulated sugar in the curing of hams, sweet-pickled bellies, and beef hams. The corn sugar did not appear to give quite as fancy a grade of bacon as the granulated sugar, but the results in this respect are inconclusive. The differences observed were largely due to slight variations in color, the bacon cured with corn sugar tending to become somewhat browner when fried than that which was cured with cane sugar. The refiners' sirup yielded satisfactory results in the curing of hams and sweet-pickled bellies (in fact it is now used to a considerable extent for this purpose), but it did not seem to give as good results in the curing of beef hams. On the whole, the results of this investigation indicate that corn sugar and refiners' sirup can be used successfully in the curing of pork in place of cane or beet sugar, and that if the need for rigid conservation of our sugar supply should again arise the entire quantity of sucrose ordinarily used in curing pork could be diverted to other uses without harm to the industry.

Investigations to determine the fitness of certain inedible oils as substitutes for lard oil as an ingredient in railway signal oil were terminated during the year. Signal oil is used largely in railway trainmen's lanterns, the oil in most general use consisting of about 75 per cent of a standard grade of petroleum and 25 or 30 per cent of lard oil or sperm oil. Studies were made of whale oil, menhaden oil, and rapeseed oil as substitutes for lard oil. Extensive tests were made in the laboratories and practical tests were made through the cooperation of three of the large railway systems. Indications are that whale oil and menhaden oil are not well suited for the purpose. Rapeseed oil gave fairly satisfactory results in laboratory tests, but railway officials were of the opinion that signal oil made with it as a substitute for lard oil is inferior to the usual mixture of lard oil

and petroleum oil. In view of those facts and because the emergency created by the war had passed, these experiments were discontinued.

The investigations in drying meats have likewise been discontinued, as there seems to be no pressing demand for meats in dried form since the conclusion of the war. The studies were carried far enough to indicate that meats could be dried and preserved in a dry state in edible form if this should become necessary.

A report on the composition and identification of meat extracts was contributed to the *Journal of Agricultural Research* (vol. XVII, No. 1, April 15, 1919). This paper, which is intended especially for chemists, health officers, and food-control officials, who have to consider the purity and proper labeling of meat extracts, contains much new information and gives directions for distinguishing extracts of different origins.

TUBERCULIN AND MALLEIN.

There were furnished to various Federal, State, county, and city officials 2,359,004 cubic centimeters of tuberculin for subcutaneous injections, an increase of about 46 per cent over the amount distributed during the preceding fiscal year; also 19,500 disks for the opthalmic test for tuberculosis and more than 5,000 doses of opthalmic tuberculin in liquid form. In addition 26,000 doses of intradermic tuberculin were prepared and distributed to various bureau representatives in the field. The opthalmic and intradermic tuberculins were produced in an experimental way, but are not yet available for general distribution. The methods used in the production of these two special tuberculins have been developed as the result of the division's research work, which is still proceeding, with the object of producing a more efficient and active tuberculin than any heretofore available.

Laboratory investigations are being conducted to determine the influence of different nutrient materials upon the growth and activity of the tubercle bacilli, the object being to simplify and at the same time to improve the methods of cultivating those organisms in the production of tuberculin on a large scale.

The amount of mallein distributed has shown a great increase, due for the most part to the requests of the War Department. There were furnished to that department 1,275,680 doses of opthalmic mallein and 1,655,130 doses of intradermic mallein, a total of 2,930,810 doses, while 113,750 doses of opthalmic mallein were sent to State and Federal officials, making a grand total of 3,044,560 doses, an increase of 75 per cent over the amount distributed during the preceding fiscal year.

OTHER WORK.

Cooperative work with the Insecticide and Fungicide Board in the examination of insecticides and fungicides intended for use in the treatment of diseases of horses, cattle, sheep, swine, and goats has been continued. Sixty-three samples were examined, of which 39 were found to be misbranded or misbranded and adulterated. Thirty-five hearings were held by inspectors in charge in the Bureau of Animal Industry in various parts of the country, and a large number of cases were examined to determine the correctness of efficacy claims made on labels.

ZOOLOGICAL DIVISION.

The Zoological Division, under Dr. B. H. Ransom, chief, has continued the investigation of parasitic diseases of animals, and the study, collection, and determination of animal parasites.

ROUNDWORMS OF SHEEP.

At the bureau farm near Vienna, Va., experiments to determine methods of rearing lambs free from parasites, or as nearly free as practically possible, have been continued. Successful results have been obtained repeatedly by dosing the ewes with 1 per cent copper-sulphate solution in the spring before turning them out to pasture with their lambs, after which the lambs with or without the ewes are changed every two weeks to fresh pasture. If kept on separate pastures from the ewes the lambs until weaning are allowed in the stable with the ewes at night and during a period in the middle of the day. For pasture, fields of appropriate size planted in various forage crops are used; also, when available, fields from which crops have been removed in the course of regular farming operations. No fields are used that have been occupied by other sheep since cultivation unless at least a year has elapsed since such occupancy. During the fall and winter the lambs may be allowed to remain on the same field for longer periods—one or two months or even longer—and during the next spring and summer they are also moved to fresh pasture only occasionally. This method does not entirely prevent infection, but the number of stomach worms and other roundworms is kept down to such an extent that they cause no apparent injury. Experiments are now in progress relating to a method under which the lambs are changed to fresh pasture only every three weeks during the summer. The question of preventing or minimizing tapeworm infestation is also being studied.

ROUNDWORMS OF HOGS.

Investigations on the common intestinal roundworm of hogs (*Ascaris lumbricoides* or *A. suum*) have been continued. Supplementing laboratory experiments, a study of conditions in the field has been made. It has been found that ascariasis in pigs is of great importance as a cause of death and stunting of growth. Invasion of the lungs by the larvæ of *Ascaris* commonly causes pneumonia, the symptoms of which are popularly known as "thumps." Even if a pig survives the invasion of the lungs by the young parasites he receives a setback from which he never fully recovers, but remains in poor condition, fails to grow at the normal rate, and at an age when he should weigh 100 pounds may weigh less than 50 pounds, sometimes less than 20 pounds. Under the usual conditions under which hogs are kept a considerable proportion of the young pigs die from ascariasis and many others are stunted in growth, so that the sum total of loss throughout the country is enormous. Methods of management to prevent losses from this cause are under investigation, and sufficient progress has been made to justify the belief that with comparatively simple precautions the damage caused by *Ascaris* can be reduced on any farm to an inconsequential amount. Several papers reporting the results of investigations on *Ascaris* have been published during the year.

TREATMENT AND CONTROL OF EXTERNAL PARASITES.

HOG MANGE.—Investigations thus far have shown that hog mange is spread mainly by direct bodily contact, that it spreads very rapidly among hogs of low vitality kept in small inclosures, that it spreads slowly among vigorous animals kept in pastures or in clean, well-lighted, roomy pens or buildings; that if not controlled there is a heavy loss from shrinkage, as well as from a high death rate; and, finally, that it can be eradicated by four dippings in a lime-sulphur or arsenical solution with intervals of six or seven days between dippings.

HOG LICE.—In experimental work one dipping or treatment with crude petroleum or cottonseed oil usually proved effective in eradicating hog lice. Extensive experiments were carried on with medicated hog wallows, and it was found that when properly constructed and used such wallows provide an effective and convenient means of treating hogs for lice and mange during hot weather.

CATTLE SCABIES.—Further experiments have confirmed former findings as to the efficacy of four dippings in lime-sulphur dip for the treatment of sarcoptic scabies of cattle. Farmers' Bulletin 1017 on cattle scab was issued.

SPINOSE EAR TICKS.—The pine-tar-cottonseed-oil remedy for ear ticks recommended in Farmers' Bulletin 980 is being used extensively in the Southwest with excellent results.

OTHER EXTERNAL PARASITES.—Experiments are in progress with reference to the relative value of different kinds of dips in protecting sheep from infection with scabies. Dips containing sulphur apparently protect a longer time than those not containing sulphur.

Herds of lousy cattle in different sections of the country have been examined at frequent intervals, and both biting and sucking lice have been found on some of the animals in each herd every month in the year. In summer they were found in small numbers, but they became more numerous and spread throughout the herd during the winter. The advisability of treating cattle for lice in the fall, before they go into winter quarters, even though they seem to be free from these parasites, is thus apparent.

ANTHELMINTICS AND TREATMENT FOR INTERNAL PARASITES.

Copper-sulphate solution was tested in the treatment of sheep for tapeworms and found only partly efficacious even when used in greater concentration than is used in the treatment for stomach worms.

In experiments to determine the most effective method of administering remedies to sheep with a view of promptly reaching the fourth stomach, better results were obtained with liquids than with pills or capsules. Apparently, however, there is not much uniformity in respect to the passage of the dose to the fourth stomach, though generally the dosing is more successful if the liquid is given slowly and with the sheep standing on all fours.

Experiments in the use of carbon bisulphid against bots in horses indicate that *Gastrophilus intestinalis* (*G. equi*) is more readily removed than *G. nasalis*, owing, presumably, to the location of many of the *G. nasalis* in the duodenum, and that 6 drams in a single dose

is apparently the minimum amount that can be depended on to remove all the bots belonging to both species. It also appears that the administration of linseed oil in connection with doses of carbon bisulphid diminishes the efficacy of the latter drug against bots and ascarids.

MISCELLANEOUS INVESTIGATIONS ON ANIMAL PARASITES.

Investigations on the possible relation between swamp fever in horses and intestinal parasites have been carried on in cooperation with the Health of Animals Branch, Canadian Department of Agriculture. These investigations have as yet led to no definite conclusions and are still in progress. The investigations on the gape-worm of chickens have been continued.

Studies have been made of the effects of substances obtained from the tissues of *Ascaris*, *Ancylostoma*, sheep tapeworms, and other parasites upon the blood of various animals, and in some cases these substances have been found to have a hemolytic action; also in certain instances an agglutinating effect upon red blood corpuscles. It has also been determined that experimental animals in certain stages of trichinosis are highly sensitive to injections of blood serum from another trichinosis animal. Highly interesting results have been obtained in experiments with anaphylactic and precipitin reactions in which extracts of various species of parasites have been tested against one another. A preliminary report on the hemolytic action of *Ascaris* extracts has been published.

During the fiscal year 131 imported sheep dogs were examined for the presence of parasites transmissible to live stock. Of these 62 were free from intestinal parasites as determined by fecal examinations and 69 were infested. Twenty-two showed the presence of tapeworms and received anthelmintic treatment before release from quarantine. In one case the tapeworms expelled by treatment proved to be of the species known as the gid tapeworm. It is because of the danger of this tapeworm to livestock, especially sheep, that imported sheep dogs are subjected to quarantine. This is the first case of gid tapeworm that has been encountered since the inauguration of the quarantine, a number of years ago.

A study has been made of several species of flukes and the results prepared for publication. A comprehensive paper on the tapeworms of dogs and other carnivores, some of which are transmissible to human beings and live stock, has been published, also a report of observations on intestinal trichinae. The portion of the Index-Catalogue of Medical and Veterinary Zoology relating to nematodes which has been prepared in cooperation with the Public Health Service is now being printed.

MISCELLANEOUS DIVISION.

The Miscellaneous Division, of which Dr. A. M. Farrington is chief, has continued its work relating to the personnel of the bureau and to veterinary education.

BUREAU PERSONNEL.

At the beginning of the fiscal year the persons in the employ of the bureau numbered 5,221. During the year there were 1,556 additions, made up as follows: Appointments, 1,458; transfers from other

branches of the Government service, 16; reinstatements, 82. During the same period there were 1,956 separations from the service, as follows: Resignations, 1,087; deaths, 39; transfers to other bureaus or departments of the Government, 25; removals for cause, 8; all other separations, 797. This last item includes terminations of appointment by limitation or for administrative reasons, exclusive of separations for disciplinary reasons. At the end of the fiscal year the bureau personnel numbered 4,821, a decrease of 400 over the number at the beginning of the year. The unusually large number of resignations is accounted for by the fact that many of the veterinarians and lay inspectors resigned to accept other employment at higher salaries and that the special war work for stimulating agriculture was discontinued with the lapse of the special appropriation. The return of men who were in military service caused the bureau to terminate the appointments of many temporary employees. Because of the low salaries paid by the Government, the Civil Service Commission has not been able to supply a sufficient number of eligibles who will accept appointment. Nearly all the women who were employed to assist in meat-inspection work at the packing houses because men were not available have been replaced by men.

During the year nine civil-service examinations were requested and subjects and weights were furnished to the Civil Service Commission.

VETERINARY EDUCATION.

The regulations governing entrance to the examination for veterinary inspector were revised, effective September 5, 1918. The principal change consisted in raising the matriculation requirement to two years' high-school education of at least seven full units or their equivalent, instead of the former requirement of a first-grade civil-service examination, which is considered equivalent to a grammar-school education. The four-years' course of study is now in effect at all accredited veterinary colleges.

The Student Army Training Corps was inaugurated about October 1 at veterinary colleges as well as at other educational institutions, and applied principally to students who were high-school graduates. The War Department urged all veterinary students who were high-school graduates to attend State veterinary colleges. As many of these students had matriculated already at colleges where the session commenced about the middle of September, great confusion was caused by their transfer from one college to another. Following the armistice the corps was ordered disbanded the latter part of December, and still further confusion was caused by the return of many students to the colleges where they previously had matriculated. By reason of these disturbing elements the number of students in attendance at veterinary colleges was much less than usual. The total number of freshmen enrolled in all veterinary colleges for the session beginning in the fall of 1918 was 264 against 338 for the preceding year. The combined attendance at all veterinary colleges was 1,114 against 1,841 for the former year. The number of graduates was 214 against 867 for the preceding year. Two of the five accredited agricultural colleges did not enroll any veterinary students, and the other three enrolled an aggregate of only 30. Because of war conditions which prevented it from procuring an

adequate faculty, and the prospect of a small attendance of students, one veterinary college discontinued its sessions. One veterinary college in Canada was added to the accredited list. At the close of the fiscal year there were 17 accredited veterinary colleges in the United States and Canada and 8 in European countries.

OFFICE OF VIRUS-SERUM CONTROL.

The supervision of veterinary viruses, serums, antitoxins, etc., under the law of 1913, was continued by the Office of Virus-Serum Control, in charge of Dr. H. J. Shore until March 31, when he resigned, and since then the office has been in charge of Dr. D. I. Skidmore.

During the year licenses were issued to 84 firms for the preparation of 179 products for sale in interstate commerce, and 4 licenses were canceled.

Virus and serum for the prevention of hog cholera form a large part of the volume of products supervised. To determine the purity and potency of the serum and the freedom of the virus from contamination 8,480 tests of the former and 1,616 of the latter were made. The production was as follows: Serum, 673,297,647 cubic centimeters, of which 4,609,531 cubic centimeters was destroyed; virus for use simultaneously with serum, 19,963,053 cubic centimeters, of which 364,310 cubic centimeters was destroyed; virus for hyperimmunization of hogs for the production of serums, 181,750,862 cubic centimeters, of which 10,052,745 cubic centimeters was destroyed. The quantity of serum produced was very much larger than in any previous year. The demand for clear serum has increased greatly.

There were inspected and admitted to the premises of licensed establishments for use in the production and testing of antihog-cholera serum and hog-cholera virus 446,800 hogs and 3,400 calves, of which 1,187 hogs and 1 calf were rejected. In subsequent operations 25,585 additional hogs were rejected.

EXPERIMENT STATION.

The work of the experiment station at Bethesda, Md., in charge of Dr. E. C. Schroeder, superintendent, consisting in general of experiments relating to diseases of animals, during the past year has dealt mainly with the two maladies of greatest importance in the United States at this time, abortion disease and tuberculosis.

ABORTION DISEASE.

Particular attention was given to the subsequent abortion-disease history of calves produced by infected cows. The studies are not yet complete, but as far as they have gone they strongly indicate that the calves born to abortion-infected cows are no more likely to abort at their first pregnancy or to show other signs of infectious abortion disease than calves of abortion-free cows. This seems to be in accord with various observations which point to the conclusion that cattle may acquire gradually a herd immunity against abortion disease, so that the disease, though it may not die out entirely, after a while ceases to cause serious trouble in herds into which no

animals are introduced from without but which are maintained by raising the calves born in them. A number of young cattle are now being held under observation with special regard to their later abortion-disease history.

Studies regarding the significance of the bull in the spread of abortion disease have yielded only negative results, which, however, should not be interpreted hastily as justifying the use of bulls from infected herds or with those that have served promiscuously.

An important fact about abortion disease, repeatedly confirmed by experiment and observation, is that a large proportion of infected cows become more or less enduring carriers of abortion bacilli, and though they may seem normal and free from manifest physical signs of the disease they are a constant danger as a means of spreading infection.

A little work has been done with regard to the pathological significance of the bacillus of infectious abortion disease of cattle for hogs, and as this seems to be a subject of increasing economic importance, more work has been planned for the future.

TUBERCULOSIS.

The investigations on tuberculosis have been continued, and though nothing essentially new has been discovered, previously reported results have received additional confirmation. For example, the evidence we now have shows conclusively that stables which have harbored tuberculous cattle may be sufficiently cleaned, without the use of chemical disinfectants, to make them safe for healthy cattle. It is not advocated that the use of chemical germicides should be abandoned, but the results of the station's experiments indicate that thorough cleaning is more effective than germicides, if either is used alone. The two used together, in the manner in which the station uses them, the germicide as an adjunct to the cleaning and not the cleaning as an adjunct to the germicide, have a practically un-failing efficiency.

MISCELLANEOUS WORK.

Tests for the detection of virulent tubercle bacilli in market cheese have been continued and show that conditions leading to infection previously found in some kinds of cheese have been corrected.

In addition to periodic tests of the potency and freedom from injurious agents of the tuberculin prepared and sold under Government license, a considerable amount of work was done to devise an improved method for standardizing tuberculin. It is too early to report results of the latter work.

A large number of small experiment animals were raised at an expenditure much lower than would have been required had they been purchased. As in former years every available portion of the station's land was kept under intense cultivation and a considerable saving thus effected in expenditures for forage.

LIVE-STOCK PRODUCTION IN CANE-SUGAR AND COTTON DISTRICTS.

The experiments and demonstrations in live-stock production in the cane-sugar and cotton districts have been continued under the direction of a committee now consisting of William A. Taylor, chief of the Bureau of Plant Industry, chairman; B. H. Rawl, assistant chief of the Bureau of Animal Industry; George M. Rommel, chief of the Animal Husbandry Division of the Bureau of Animal Industry; and W. R. Dodson, director of extension service, Louisiana State University.

IBERIA EXPERIMENT FARM.

At the Iberia Experiment Farm, Jeanerette, La., a four years' study of the relative merits of mules and brood mares as work animals was completed. The average annual maintenance cost per mule was \$313.69, which was slightly more than for mares. The mules, however, performed more than twice as many days of work as the mares did. Mule colts foaled in the spring of 1918 were raised to 1 year of age at a cost of \$56.94; colts foaled in the spring of 1917 were raised to 2 years of age for \$156.20 and to 2½ years of age for \$201.95.

Completed experiments showed that the average cost of a feeder steer at 2 years of age was \$51.62, while the average cost of raising a heifer calf to 2 years of age was \$52.88, and to 30 months, \$88.83.

A number of steers were fed for 90 days on various silage crops suited to the southern coastal region. The steers fed on corn-and-soy-bean silage made the greatest daily gains, and this silage proved to be the most economical with a cost of \$11.14 per 100 pounds of gain, followed by silage from sorghum and soy beans, corn, sorghum, whole sugar cane, Japanese cane, and sugar cane, in the order named.

The average cost of feeding steers from birth to the fattening period (2 years 8 months) was \$69.13; fattening raised the cost to \$113.77; the net selling price was \$132.84 and the net profit \$19.07. A second lot of steers was raised to 2 years of age at a cost of \$55.04, fattened for \$39.45, and sold at a net profit of \$19.40 each. The third year's results of feeding beef cows showed that the yearly cost of maintenance per cow was \$29.98. The average cost of raising calves to 2 years of age was \$53.68.

The average cost of raising pigs to weaning time was \$3.05 for fall pigs and \$3.55 for spring pigs. In grazing experiments fall pigs (1917) made the greatest gains on field corn supplemented with tankage, while spring pigs (1918) made the best gains on corn and soy beans.

The dairy herd, headed by the Jersey bull Hillside Torono 101729, now consists of 12 purebred Jersey cows, 13 grade cows, and 23 head of growing stock. The average cost of producing 1 gallon of milk, including labor, feed, and pasturage, was \$0.339. The cost of raising heifer calves to the age of 1 year averaged \$77.50 per head. Seven of the registered cows have been entered in the Register of Merit and three are now on test. Purebred cows gave a profit of \$143.44 per head over feed cost as compared with \$115.08 from grade cows.

LIVE-STOCK EXTENSION.

By means of demonstrations, short courses, and lectures, extension specialists have brought before the farmers of the cane and cotton sections the value of live-stock production. Direct aid has been given to beginners in live-stock growing, both in the care and management of the stock and in the planning and construction of barns, silos, and other buildings, and assistance has been given in the selection and purchase of breeding stock. Marketing problems have also received special attention.

REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
Washington, D. C., September 22, 1919.

SIR: I have the honor to submit herewith a report of the work of the Bureau of Plant Industry for the fiscal year ended June 30, 1919.

Respectfully,

WM. A. TAYLOR,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

WORK AND ORGANIZATION OF THE BUREAU.

The Bureau of Plant Industry undertakes the study and economic solution of plant problems, especially in relation to crop production and utilization. These activities include the improvement of useful plants by breeding and cultural methods, the investigation of destructive plant diseases and the development of methods for their control, the introduction and acclimatization of new plants from other parts of the world, the extension of the use of valuable crops and the development of improved methods for their utilization, the determination of both agronomic and economic crop relationships, and the meeting of emergencies incident to crop production as they arise from time to time throughout the country.

The work of the bureau during the year has been carried on with the following organization:

Laboratory of Plant Pathology	Erwin F. Smith, Pathologist in Charge.
Pathological Collections	Flora W. Patterson, Mycologist in Charge.
Fruit-Disease Investigations	M. B. Waite, Pathologist in Charge.
Investigations in Forest Pathology	Haven Metcalf, Pathologist in Charge.
Citrus-Canker Eradication	Directed by K. F. Kellerman, Associate Chief of Bureau.
Blister-Rust Control	S. B. Detwiler, Forest Pathologist in Charge.
Cotton, Truck, and Forage Crop Disease Investigations	W. A. Orton, Pathologist in Charge.
Crop Physiology and Breeding Investigations	W. T. Swingle, Physiologist in Charge.
Soil Bacteriology and Plant-Nutrition Investigations	Directed by K. F. Kellerman, Associate Chief of Bureau.
Soil-Fertility Investigations	Oswald Schreiner, Biochemist in Charge.
Acclimatization and Adaptation of Crop Plants; Cotton Breeding	O. F. Cook, Bionomist in Charge.
Fiber-Plant Investigations	L. H. Dewey, Botanist in Charge.

Drug-Plant and Poisonous-Plant Investigations-----	W. W. Stockberger, Physiologist in Charge.
Physiological and Fermentation Investigations-----	R. H. True, Physiologist in Charge.
Agricultural Technology-----	N. A. Cobb, Technologist in Charge.
Biophysical Investigations-----	Lyman J. Briggs, Biophysicist in Charge.
Seed-Testing Laboratories; Enforcement of Seed-Importation Act-----	E. Brown, Botanist in Charge.
Cereal Investigations-----	C. R. Ball, Cerealist in Charge.
Corn Investigations-----	C. P. Hartley, Physiologist in Charge.
Tobacco Investigations-----	W. W. Garner, Physiologist in Charge.
Paper-Plant Investigations-----	Directed by C. J. Brand, Chief of Bureau of Markets.
Alkali and Drought Resistant Plant Investigations-----	T. H. Kearney, Physiologist in Charge.
Sugar-Plant Investigations-----	C. O. Townsend, Pathologist in Charge.
Economic and Systematic Botany-----	Frederick V. Coville, Botanist in Charge.
Dry-Land Agriculture Investigations-----	E. C. Chilcott, Agriculturist in Charge.
Western Irrigation Agriculture-----	C. S. Seofield, Agriculturist in Charge.
Horticultural and Pomological Investigations-----	L. C. Corbett, Horticulturist and Pomologist in Charge.
Arlington Experimental Farm-----	E. C. Butterfield, Assistant Horticulturist in Charge.
Gardens and Grounds-----	E. M. Byrnes, Assistant in Charge.
Foreign Seed and Plant Introduction-----	David Fairchild, Agricultural Explorer in Charge.
Forage-Crop Investigations-----	C. V. Piper, Agrostologist in Charge.
Congressional Seed Distribution-----	R. A. Oakley, Agronomist in Charge.
Demonstrations on Reclamation Projects-----	A. C. Cooley, Agriculturist in Charge.
Seed Stocks Committee-----	R. A. Oakley, Chairman.

From September 1, 1918, to August 31, 1919, the changes in the personnel of the bureau were as follows: Resignations, 686; deaths, 13; transfers from bureau, 59; furloughs, 30; terminations of appointments, 957; dismissals, 1; making a total of 1,746 employees dropped from the rolls during that period. In the same period 1,600 appointments were made, leaving a net decrease of 146 in the total force of the bureau. On September 1, 1919, the numerical strength of the bureau was as follows: In Washington, 868; outside of Washington, 1,235; total, 2,103. The total number of employees in the bureau on the same date a year ago was 2,249.

The activities of the bureau during the year are outlined more or less fully in the 37 technical papers appearing in the *Journal of Agricultural Research*, 4 papers in the *Yearbook*, 29 *Farmers' Bulletins*, and 60 *Department Bulletins*, circulars, etc. Certain of the more striking results of the year's work, however, are here summarized.

AGRONOMIC AND HORTICULTURAL INVESTIGATIONS.

WHEAT.

The classification of American wheat varieties is progressing rapidly. Complete descriptions of about 135 commercially grown varieties have been given, and keys have been constructed by which varieties may be classified and identified. This classification is being checked in the field again during the season of 1919 and will then be ready for publication.

In connection with the classification of wheats a very comprehensive varietal survey has been undertaken in cooperation with the Bureau of Crop Estimates. Schedules to determine the distribution of wheat varieties, the source from which they came, the date of their introduction into the community, and the percentage which each one represents of the total wheat acreage in the community have been sent out to some 65,000 crop reporters. The return schedules have been studied, and in thousands of cases letters of inquiry sent asking for additional information and for samples. For the first time in the history of wheat growing in America it will be possible to map the distribution of wheat varieties and to learn the large number of names under which the same varieties are known in different parts of the country.

In connection with the problem of the winterkilling of wheat it has been necessary to study the effect of different methods of seeding on the winter survival of the resulting plants. Preliminary cooperative experiments seem to indicate that drilling may be a factor in some sections. The geographic scope of these experiments is being broadened.

RICE.

A method of shocking rice developed cooperatively at the Crowley Rice Station in Louisiana proved its value again in the autumn of 1918. Wherever this method was used, comparatively little damage was done to the shocked grain by the heavy rains prevailing after harvest time.

Experiments to determine what crop may be grown profitably in rotation with rice in the Sacramento Valley again have resulted negatively. The data obtained indicate that cotton may become a commercial crop where the water table can be controlled and the crop planted early. A careful survey was made in portions of Georgia, Florida, and Alabama to determine what varieties and methods of growing will permit the production of rice without irrigation, in quantities sufficient for home use at least.

A general survey of Porto Rico was made in 1917 to determine the possibility of commercial rice growing on that island. This was followed by experiments undertaken cooperatively with the Porto Rico Experiment Station and with sugar planters at several points. This work is being continued during the crop season of 1919, and the results indicate that there is a promising outlook for commercial rice growing in Porto Rico. One variety produced a fair yield under conditions of drought so severe that the native varieties were a complete failure.

GRAIN SORGHUMS.

Long-continued experiments in the production and improvement of grain-sorghum varieties in the dry and elevated portions of the southern Great Plains area warrant the following conclusions concerning this group of grain crops so important in that section:

(1) Many varieties produce well in favorable seasons. Only well-adapted varieties produce well in the less favorable and in unfavorable seasons, which comprise about three-quarters of the total number.

(2) Earliness is the most important single factor in the varietal adaptation of grain-sorghum crops to the conditions obtaining on the high plains of the Texas Panhandle.

(3) Dwarfness is the next most important factor in the adaptation of these crops.

(4) The combination of earliness and dwarfness is extremely efficient in insuring adaptation to environmental conditions which include frequent periods of drought.

(5) Dwarf milo, Dawn (dwarf) kafir, and Sunrise (early) kafir are shown to be well-adapted varieties.

(6) Dwarf milo and Dawn kafir are meeting with wide approval on the farms of the high, dry plains.

(7) Germination and stand are governed largely by local conditions at sowing time.

(8) Tillering, or the production of suckers, is a varietal or group character to some extent. In part, it is correlated with stand and seasonal conditions.

(9) The production of erect heads is largely a group or varietal character, but is influenced by the same factors as tillering.

BROOM CORN.

Experiments in the improvement and culture of broom corn have been conducted for several years at the Woodward Dry Land Field Station in western Oklahoma. The results indicate that in that district the crops should be sown in the first half of May or the last half of June. These seeding periods bring the crop into head either before or after the hot dry period which usually occurs about the middle of August. Spacing the rows 7 feet apart, with the plants twice as thick in the rows, gave no advantage over rows spaced 3.5 feet apart with the usual stand in the row. When harvesting is done while the seeds are in the dough stage, a higher yield and apparently a better quality of brush are obtained than when harvesting occurs at an earlier or later stage in the development of the plant.

PASTURE IMPROVEMENT.

The problem of improving pastures is becoming increasingly important, as the high prices of foods are more and more forcing attention to the only really cheap feed—pasturage. Confirmation of the bluegrass-pasture experiments, in which it was shown that heavy pasturing is much the best method, both agronomically and economically, has been secured by two investigators working on other pasture grasses. Better handling of northern pastures is a matter of great importance, but, unfortunately, available facilities for experiments and demonstrations are wholly inadequate.

On the coastal plains of the South, unless the soils are much affected by drought, carpet grass, supplemented with lespedeza, makes excellent pasture. As a rule, *Paspalum dilatatum* (golden crown grass) is also excellent. Efforts are being made, with the aid of a new stripping machine, to place carpet-grass seed on the market in adequate quantity. Several newly introduced grasses are promising as pasture possibilities, but the absence of any facilities for experimental trials makes progress very slow. The pasture problem on the Coastal Plain must be solved in order to bring about agricultural utilization of these lands at the present time.

RANGE IMPROVEMENT.

There is a constant demand for grasses that will increase the amount of feed on the semiarid range lands, over and above that which may be secured by rational grazing of the land under fence. Sweet clover has proved very valuable, but much of the area is too

dry for this plant. There is reason to believe that a systematic testing of the numerous grasses and legumes secured by botanical explorations in Central Asia will disclose species that will solve the problem.

VITICULTURAL INVESTIGATIONS.

The viticultural problem of the wine-grape districts of the Pacific coast from the production standpoint becomes one primarily of developing the Panariti and other currant grapes and the culture of the Ohanez and other late varieties, which it is believed can be produced advantageously in this country, with a view to their taking the place of the Almeria and other types of long-keeping grapes now imported into this country more or less from Spain and elsewhere. The results of investigations already in progress have seemingly demonstrated the practicability of growing these varieties on a commercial basis.

From the cultural standpoint, the use of cover crops in the Oakville Experiment Vineyard in California has demonstrated the importance of such crops in vineyard maintenance under such conditions as those obtaining there. The results from the experimental vineyards in California, which have been in progress for some 12 or 15 years, on resistant varieties, adaptability, congeniality, productiveness, etc., will serve as a basis for such modifications of the work as conditions may make necessary in the future.

The work with American bunch grapes has been confined chiefly to the use of fertilizers, pruning experiments, and other cultural features carried on in the experiment vineyard at Vineland, N. J. This vineyard has also served as a source of supply for raw material in connection with the fruit-utilization investigations, particularly in studying the value of different grape varieties for the making of unfermented juice.

The Muscadine grape investigations have continued to yield exceedingly important results. While the breeding investigations, which promise very much for this industry, were temporarily interrupted by war conditions, the work along other lines, particularly the utilization of Muscadine grapes, has been stressed both because of the relation of the utilization features to the food supply in the conservation of this fruit and the relation of this phase of the work to cultural problems. It has been determined that there is a pronounced difference in varieties in their value for the making of fresh juice and other products. The Thomas is the best of the varieties now commonly grown for unfermented juice, and it has high merit compared with other varieties for most other uses.

Under the cultural and particularly the pruning methods used in the experiment vineyard at the Pender Test Farm, Willard, N. C., excellent crops have been produced when, because of unfavorable climatic conditions, other vineyards and vines in the surrounding neighborhood have yielded little or no fruit.

SUBTROPICAL FRUITS.

The work with subtropical fruits has included studies of avocado varieties for Florida and citrus fruits for Florida, an investigation of the Satsuma orange varieties in the Gulf States, a study of avocado varieties for California, and the production of olives in California.

Of the avocado varieties in Florida the Trapp, which is the leading fall variety of the West Indian race, will probably be the one most commonly planted in protected localities for some years to come, as in the past. Of the Guatemalan varieties, which are thicker skinned and harder than the West Indian avocado, the Fuerte, which has come to be one of the standard varieties of California, appears to be one of the best for conditions in Florida. It maintains there the same high oil content and other qualities that characterized it when grown in California.

Further work in California confirms the wisdom of the selections made by the California Avocado Association, announced in a circular published October 25, 1917, which recommends the Fuerte, Spinks, Blakeman, Lyon, Dickinson, Taft, Sharpless, and Puebla varieties. The Taft does not seem to be as hardy as many of the other varieties in the list, however, and for this reason it should be planted only in specially protected localities. Furthermore, it is a slow grower and the trees do not begin fruiting until they are 5 or 6 years old, which is at least two years later than most of the other recommended varieties. The Lyon does not make a very satisfactory growth except in the Montebello and Whittier districts. There is some question whether these two varieties should be retained in the list. The other six, however, appear to be specially well suited to California conditions. The Puebla is gaining in favor, and it will probably be extensively planted in the future.

A further study of Florida citrus varieties so far as they relate to oranges confirms the conviction, which is shared by officials of the Florida Agricultural Experiment Station, the State Plant Board, and a number of prominent nurserymen and growers, that the "accredited" list recommended by the Citrus Seminar in 1916 for planting in Florida should be continued. This list included, in the order of their maturity, the Parson (*Parson Brown*), Homosassa, Pineapple, Valencia, and Lue (*Lue Gim Gong*) varieties. Some growers and nurserymen believe that the Lue may be eliminated, as it resembles the Valencia in so many particulars.

Comprehensive investigations of the Satsuma orange industry in the Gulf States, and particularly in Alabama, have shown that there are at least three different varieties of these oranges being grown more or less extensively in this region and that the name Satsuma is, in fact, a group name rather than a variety name. This interpretation of the significance of this name explains many of the wide differences previously observed in the fruit grown and passing as "Satsuma oranges." The Satsuma varieties of principal importance are the Owari and Ikeda. The Zairai orange is found in a few orchards, but it is relatively unimportant except for the reason that, because of its unlikeness to other varieties, it may continue to create confusion if the fact that it does occur is not fully recognized.

In connection with the bud-selection work in California considerable attention has been given to the pruning of citrus trees. It is expected that the results of this work will be prepared at an early date for publication. The most striking features of these investigations have been what appears to be a clear-cut demonstration of the fact that the very heavy pruning practiced by some growers is detrimental, but that a limited amount of pruning, wisely applied,

is conducive to fruit production. Incident to the bud-selection work it appears evident that trees propagated from those having a high yielding record of desirable fruit require less pruning to keep them in good form and in good productive condition than do trees propagated according to ordinary nursery practices. The bud-selection work which has been in progress with citrus fruits in California for a number of years has been continued, though on a somewhat restricted scale.

From a practical commercial standpoint, the performance records of individual trees which have accumulated up to the present time are serving an exceedingly important purpose, in that they are used as a basis for choosing the trees selected as a source of bud wood by the California Fruit Growers' Exchange, through its bud-selection department. This department was organized for the purpose of furnishing buds cut from trees of known bearing habits to nurserymen or citrus growers who desired to use them for top-budding trees in their groves which were known to be relatively unproductive or which produced fruit of undesirable characteristics. The individual tree-performance records of the Ruby variety in a 10-acre orchard at Corona, Calif., have been continued, as during the two preceding years. The information thus obtained emphasizes the striking frequency of bud variation in this variety. This, in turn, emphasizes the importance of selecting buds for propagation not only from trees of known bearing proclivities, but even from limbs of known bearing proclivities, because trees are exceedingly common which in the main bear fruit of desirable type but have some limbs on which fruit that varies from the accepted standard is produced.

The records which are now being accumulated confirm more and more emphatically the previously drawn conclusion that the characteristics of the parent tree are perpetuated in the progeny with no important exception or variation. The progenies in experimental plantings are producing fruit comparable in every particular with that borne by the parent trees of large-yielding or other desirable characteristics, or, like the parent trees, they are barren or relatively barren.

In order that the standard strains of the different kinds and varieties which have been established may be fully maintained and the strains accurately recorded, additional descriptive notes and photographs of selected citrus trees and their fruits have been secured during the past year.

A large number of commercial citrus-performance records are being made, the interest of the growers having increased each year. The utility of these records is practical rather than scientific. They enable the grower to determine inferior trees for removal or top-working, as well as make possible the selection of superior trees from which buds for use in top-working may be obtained. It has been found that these commercial performance records can be made in Washington Navel and Valencia orange and in Marsh grapefruit orchards at an average cost of about \$1 an acre each year, while similar records in lemon groves cost about \$10, the difference being due to the greater number of pickings in the case of the lemons.

Considerable time has been devoted during the year to assisting growers in introducing individual-tree records and to the utilization of the data thus secured.

The progress of the bud-selection department of the California Fruit Growers' Exchange, which is the direct outgrowth of the work of the Bureau of Plant Industry, is of interest in the present connection particularly in view of the fact that more or less supervisory attention is being given to it. In the first year of this work, the representative of the exchange in charge of it handled a total of 260,000 citrus buds. These buds were sold to members of the exchange at the rate of 3 cents each and to nonmembers at 3½ cents each. Under these conditions the work was found to be self-supporting. The past year, owing to the increased knowledge that could be brought to bear in the work and the consequent better selection of bud wood, the price of buds was raised to 5 cents each to members of the exchange and 6 cents each to nonmembers. Under these conditions, the demand for buds has increased to such an extent that at the present time there is a greater demand for them than can be met. The citrus nurserymen who have used these buds have obtained better results from them than from the sucker-wood buds that were formerly used in propagation. Furthermore, it has become exceedingly difficult for nurserymen who do not use the selected buds in propagation to dispose of their stock when it is grown.

The work with olives has continued along the line of standardizing the varieties, of which there are apparently several being planted under the name "Mission." The varieties commonly planted have also been studied for the purpose of standardizing the product.

THE COMMERCIAL CULTURE OF SMYRNA FIGS.

The work on the life history and breeding of figs and caprifigs has been given a great impetus by the publication of a bulletin on the commercial culture of the Smyrna fig in this country.

The Smyrna fig industry is growing very rapidly in California, and thousands of acres are being planted every year. It is not improbable that this country will soon produce all the figs it needs.

Much of the success of Smyrna fig culture in California has been due to the fact that the United States Department of Agriculture has been able to maintain a caprifig orchard at Loomis, Calif., from which caprifigs have been distributed free to growers. Before this distribution was arranged for, many small growers of Smyrna figs became discouraged, and some even dug up their orchards. When Smyrna figs and caprifigs are planted together, the caprifigs do not bear enough fruits to properly caprify the crop until several years after the trees begin to bear. For this reason, a young orchard is dependent on importing the needed caprifigs during the first few years. It was to supply this need that a seedling fig orchard at Loomis was leased by the Bureau of Plant Industry and the general distribution of caprifigs to Smyrna fig growers arranged.

Many new varieties of caprifigs have been brought to light, some of them very important in commercial Smyrna fig culture. A number of strains of the Lob Ingir (the best type of Smyrna fig) have been found that seem to be immune to splitting and so appear very promising for commercial culture.

Many thousands of seedling figs have been distributed to co-operators in the fig-growing regions of California, Arizona, and Texas, and some promising new varieties have been originated by proper selection of male pollen.

In the fall of 1917 the fig insect was established in certain old seedling caprifig trees in Brunswick, Ga., and since then a number of other caprifig trees have been similarly treated. Thanks to this local supply of caprifigs, it has been possible to caprify and bring into fruiting many sterile seedling Smyrna fig trees growing in the Southeastern States. Some of these trees bear a very high grade of fruit, very promising for use as fresh fruit or for canning. It is still doubtful whether figs grown in the southeastern United States can be dried to advantage. At any rate, it is a matter of much interest and of some economic significance that many old sterile fig trees in this region are really Smyrna seedlings, approximately half being Smyrna trees and the others caprifig varieties.

COMMERCIAL DATE CULTURE.

Date culture, though still conducted on a small scale, is a recognized commercial fruit industry which gives promise of steady growth. The culture of the Deglet Noor, the finest of the imported date varieties, has already become well established in California.

At the present time American methods of date culture are probably more advanced than those of any other date-growing country in the world, in spite of the fact that our experience is limited to practically two decades.

NUT INVESTIGATIONS.

The work with nuts during the past year has been confined largely to pecans and has consisted for the most part in a continuation of studies previously inaugurated, including an investigation of the range of the species, the adaptability of varieties to different regions, methods of propagation, soil improvement, orchard management, and methods of harvesting, curing, packing, and handling the product.

From a continued study of varieties it appears that a considerable proportion of the varieties now being planted are so far below the general average of the best sorts in production and other important characteristics as to justify their elimination. It is becoming more and more evident that greater attention should be given to the matter of stocks for use in propagating pecans in the nursery.

A series of irrigation experiments begun during 1917 has been continued, although because of the rather heavy rainfall which has characterized the climatic conditions since the inauguration of these experiments there has been little opportunity to study the influence of the application of water during the dry periods which commonly occur and to which are attributed as a possible cause some of the adverse results experienced, such as the premature dropping of the nuts and other difficulties.

A series of fertilizer experiments begun in 1918 is being continued. Although the work is of too recent origin to report results, certain records suggest a slight increase in the yield of fertilized trees.

A further study of varieties is being made in the States bordering the area recognized as definitely within the pecan-growing territory. Planters in Oklahoma, Tennessee, Kentucky, Indiana, Ohio, Illinois, Missouri, and Kansas are becoming interested in the possibility of planting pecans and are seeking information with regard to varieties possessing the necessary qualities when grown under their conditions.

VEGETABLE STORAGE AND STORAGE LIFE FACTORS.

In cooperation with the Bureau of Markets, handling and life-history studies of tomatoes were carried on in Florida, particularly with a view to determining at what degree of ripeness tomatoes should be picked for shipment to northern markets in order that the best carrying qualities and the best dessert qualities might be realized. It was found, among other things, that the age of the tomato, that is, the time elapsing between the blossoming stage and the picking date, was of primary importance rather than the size of the fruits.

In the shipping tests with tomatoes it was determined that it was better not to wrap the individual fruits; the ripening process takes place better under full ventilation; if held under unventilated conditions offensive tastes and odors are likely to develop.

Freezing work on potatoes has been conducted, which is similar in character to the freezing work with relation to fruits, involving a determination of the temperature and the length of exposure to such temperature which will result in frost injury.

The behavior of celery, cauliflower, and lettuce when held in different storage temperatures has been critically studied. The practicability of storing these products on a very much more extensive scale than has been followed heretofore is indicated. Cauliflower, which as a rule has not been stored except for very brief periods, can apparently be held at a temperature of 32° F. for a period of 30 to 40 days.

A very limited amount of work has been done in the cold storage of flowers. The results secured in a preliminary way suggest the practicability of florists inaugurating very different methods of holding their flowers than those now in use wherever conditions may so suggest. Roses held at a temperature of 32° F. were in fair condition long after they would have completely deteriorated under the usual method of handling. Easter lilies after being stored for three weeks were removed in good condition and remained so for four days after being placed at common room temperature. Held for two weeks in storage Easter lilies stood up for five days in a warm room. Peonies and other flowers held up a surprisingly long time in a temperature of 32° F.

INVESTIGATIONS OF TRUCK-CROP PRODUCTION.

The work with sweet potatoes has been considerably enlarged both because of the need of fundamental information along certain lines and the importance of the crop in a large part of the country as a source of food. The work is carried on principally at Arlington Farm and at Florence, S. C., at the Pee Dee substation in connection with the South Carolina Agricultural Experiment Station. The work consists of a comprehensive study of varieties, for the purpose of working out a key by means of which varieties can be identified, and the varieties adapted to different regions and for such purposes as table use, stock feed, and as a possible source of sirup, sugar, and perhaps starch and other products, can be determined. Under the cultural and development phases of the work, investigations are being made in hill selection for the securing of seed stock, selections being made with regard to those having no string, those having a maxi-

imum number of strings, those having a maximum number of first-grade table potatoes, those having a maximum yield irrespective of size or shape, the latter having its particular application in the production of potatoes for stock feed and the making of sirup, sugar, starch, or alcohol, where a large yield is the primary feature. The object of the selections is self-evident, except that one where the selections are made with a view to producing the maximum number of strings; the importance of this is simply a matter of comparison and for securing a definite demonstration of the results in selection.

Investigational work in the curing of sweet potatoes was also carried on with very satisfactory results, it being shown that with proper handling and storage conditions sweet potatoes can be carried through the winter and as late as April 1 with not to exceed 1 per cent of loss from decay.

The work with peanuts has been along lines comparable with those followed in the sweet-potato work. Methods of planting, selection of seed, the improvement of yield, and cultivating and handling the crop have been studied. The study of varieties has made evident the fact that most of the so-called varieties now to be found in the trade are in fact merely old standard varieties with new or local names and that there are only about six distinct varieties grown in this country. Selected strains of some of these varieties are being made, with a view to producing those particularly adapted for definite purposes, such as the making of peanut oil a high-grade table and cooking oil, also employed in the manufacture of oleomargarine, and to some extent in making soap, etc., and also strains that are adapted for human food in the form of peanut meal, peanut butter, and other products. High-yielding strains are desirable for stock and dairy feeds.

IRISH POTATO INVESTIGATIONS.

The work under the Irish potato project previously inaugurated has been continued during the past year. These lines include a study and classification of varieties, a study of the adaptability of varieties to different conditions, selection studies in connection with the development of improved strains, a study of seedlings produced in breeding, studies of the best rate of seeding and of the use of whole or cut seed, and various other problems of a similar character.

In addition to these studies, all of which have been in progress for a number of years, attention was especially devoted to the development of improved seed stocks, it being realized that the seed stocks commonly available to potato growers contain many mixtures, not infrequently diseased and as a rule not as productive as they should be. It is a recognized fact that the yield of potatoes in this country is far below that secured in Germany and in some other countries. This difference is commonly attributed to the use of relatively inferior seed stock.

A collection of South American varieties of potatoes, including a number of the yellow-flesh types, has been grown for study each season for a number of years past. The full collection was grown in 1918, as it was the preceding year, at Swannanoa, N. C., and Presque Isle, Me., but without any very promising results, those obtained in 1918 being even less promising than were those in 1917. It now seems evident that, with the possible exception of two or three

varieties, this South American collection is without value for commercial purposes. The work with this group of potatoes will, therefore, be very much curtailed in the future.

The seed-improvement work is being carried on in cooperation with the agricultural experiment stations in practically all of the important potato-producing States. The best seed stock of the leading varieties in different regions is being grown in the different States. During the progress of the season the various plats are inspected several times for the purpose of eliminating diseased plants and those which are not true to name or true to type, and at the harvest period carefully studied selections are made for the purpose of obtaining the best strains of the different varieties. These potatoes in turn will be used for seed purposes with a view of developing stocks that are true to name, true to type, free from disease communicable through the seed and at the same time possess high-yielding proclivities.

VEGETABLE UTILIZATION WORK.

The investigations of the utilization of vegetables have been conducted primarily from the standpoint of the producer, with a view to securing information which will enable the farmer or the grower successfully and profitably to utilize his surplus crops or the crops which he may grow especially for drying or canning.

The activities have been directed toward the determination of varieties best adapted to the different purposes and to methods of procedure which will give a technique that the farmer can apply with reasonable assurance of the results.

In the canning of vegetables the fact has been developed that there is a very wide variation in the behavior of different varieties; for instance, certain varieties of beets appear to be much better adapted for canning than others. Methods of canning carried on with a view of determining processes which will give the greatest possible degree of success under the widest range of conditions are being investigated, it being recognized that most of the methods now used not infrequently give faulty results under many different conditions.

One of the most important activities has been directed toward the working out of satisfactory methods of canning sweet potatoes. The methods now used, both on the farm and by commercial canneries, result in a product which has a more or less burnt and otherwise unpleasant flavor. This burnt taste appears to be the result of caramelization. A method has been worked out whereby this is not only avoided but which results in a product that is essentially like the sweet potato when freshly prepared for table use. In the same connection canning tests of 34 different varieties of sweet potatoes have been made. These tests have shown a wide variation in the value of different varieties for these purposes. Other features of canning technique are being developed along the lines of the fundamental principles involved, which it is believed will have a far-reaching effect on farm canning.

BULB-CULTURE INVESTIGATIONS.

During the year one half of our bulb stocks have been removed to the new bulb farm at Bellingham. Owing to a shortage of labor the other half was left undug on rented ground. The total excess

production for the year was about 350,000 bulbs, or one minimum car-load, which supplied the entire quota of the congressional distribution. These stocks proved to be fully up to the standard. The narcissuses were especially commented upon as of superior quality. Of the minor lists of stocks not before handled, the Dutch irises, branching tulips, our native camassias, and some of the newer narcissuses have done especially well. The propagation of the lily is promising. Many species grow readily in this region by simply drilling the seed in open ground in autumn. Even such a species as *Lilium washingtonianum* is now promising under practically open-ground conditions, most of the plants not appearing above ground, however, until the second spring.

The preservation of bulbs taken out of beds after flowering has proved to be thoroughly practicable this season. Some 20 or more thousand tulips and narcissuses from the department grounds will give 80 per cent of flowering bulbs, besides an average increase of 160 per cent of small bulbs, which are just as good planting stock as can be secured anywhere. One year will bring the 80 per cent of flowering stock to first-class condition and half of the small stock to flowering size. This class of conservation is to be encouraged and no doubt will be practical now that bulbous stocks have doubled in price.

It has been demonstrated that the beautiful Palestine irises can be grown very satisfactorily in the Sacramento Valley, and probably in the other interior valleys of California. Our experiments show that a reproduction of $3\frac{1}{2}$ fold may be expected the first two years after importation; also, what is known as the "Juno" group succeeds well here. In general, these groups, although in some respects the most attractive of the great iris family, have not been considered successful in this country up to this time.

The investigations of Easter lilies conducted at Arlington Farm, near Washington, have revealed a number of things of importance:

(1) Our seedling stocks after two years give a reproduction of bulblets which is ample for all purposes of propagation. This means that once a seedling strain has been developed a stock can be worked up very rapidly by vegetative methods, and these same methods will serve to continue the increase.

(2) Stem bulblets, which form in the axils of the leaves near the surface of the ground, are 6 to 12 in number under ordinary conditions, and several of them will give one, two, or three flowers the first year and grow to good flowering size with one year's cultivation.

(3) An increased bulblet propagation can be secured by plunging the pots, by hilling up around the plants, or by layering the stems.

(4) Seed dried for two or three months germinates in a shorter time than that which is sown immediately upon its maturity.

(5) Home-grown bulbs 3 to $6\frac{1}{2}$ inches in circumference average three to five flowers to the stem when forced for Easter.

(6) A few flowers are secured in one year from seed.

(7) Seed sown in July, when carried on in pots, will produce bulbs which can be forced for the second Easter following.

(8) These facts enable growers to produce their own Easter lily bulbs from seed in one year's time, the seedlings being carried in pots. After flowering, the bulbs not disposed of can be carried out of doors south of Philadelphia and will be ready to force again after one year's recuperation.

(9) Stocks thus produced are free from disease.

CORN CULTURE.

Experiments have been conducted to demonstrate the practicability and value of the earlier planting of corn. Proof has been obtained that in many instances the earlier planting of large productive

varieties is much more profitable than the normal planting of early-maturing varieties. By much earlier than normal planting it has been found that larger growing varieties can be profitably grown for ensilage in northern localities and much better yields secured than by planting the smaller native varieties at the usual corn-planting date. In southern localities, by planting small short-season varieties earlier than normal much earlier maturity can be secured, thus affording a supply of corn for very early feeding. Many rather soft varieties produce sound corn when planted early in southern localities, but rot badly when planted late.

Investigations of cultural methods have shown that in localities where moisture is a limiting factor, the practice of planting in alternate rows short and long season varieties has increased yields as compared with either variety in pure plantings. It has also been observed that varieties differ in their ability to adapt themselves and their grain production to varying stands. When given increased spacing prolific varieties have shown ability to increase their grain production much more satisfactorily than have the single-ear varieties. This is an important factor in ordinary planting where missing places are frequent. In sections to which prolific varieties are adapted, they are more desirable than single-ear varieties because of their ability to make up by increased grain production deficiencies in stand.

Crossbreeding and experiments with unusual types of corn from different parts of the world promise interesting and profitable results.

Progress is being made in isolating uniform types within a variety. It has been found that so-called varieties of corn are largely conglomerates of many distinct types. In arriving at basic facts in breeding work it is necessary that these uniform types be segregated.

PLANT BREEDING.

WHEAT.

Wheat-breeding investigations in cooperation with the North Dakota Agricultural Experiment Station have resulted in the production of the Kota variety by selection from a mixture of Russian wheat. This is a hard red spring common wheat, both early and productive, with the additional valuable quality of high resistance to black stem rust. Preliminary milling experiments indicate that it is of good milling quality also. It will be increased for commercial growing and also will be used as a basis for further breeding.

Acme, a variety of durum wheat developed by selection from the Kubanka in cooperation with the South Dakota Experiment Station, is not only a high-yielding variety, but shows a high degree of resistance to black-stem rust. It has now been introduced into commercial cultivation in South Dakota.

In cooperation with the Cornell Agricultural Experiment Station in New York, there have been developed several superior wheat selections, both white kerneled and red kerneled. The work has progressed to the point where these selections are now being distributed to selected cooperating farmers in those sections of New York to which they are adapted.

Losses from the winterkilling of wheat have been very severe in different years, due apparently to several causes. Cooperative experiments in breeding wheat for winter hardiness have been established at the State experiment stations in Kansas and Minnesota. Already some promising winter-hardy strains have been assembled for use as a basis in breeding and studies of adaptation to severe conditions.

Very extensive studies of inheritance in wheat are being carried on at the Arlington Experiment Farm and at the Cornell Agricultural Experiment Station. Various characters of the wheat plant are being studied, including the inheritance of awns, color, and other characters of the glumes, color of grain, length of awns, straw characters, and various other characters that have a more or less economic importance. A very interesting feature of the work at the Cornell station is the synthetic production of a plant which is practically identical with the wild emmer or so-called wild wheat of Palestine.

OATS.

In cooperation with the Iowa Agricultural Experiment Station, the oat variety Iowar has been produced by selection from the Sixty-Day variety. This is a high-yielding early strain of white oats, producing several bushels more per acre than ordinary varieties. It was first distributed to selected Iowa farmers in the spring of 1919, and about 250 acres were grown this season.

Extensive breeding operations for the improvement of oat varieties are being conducted in cooperation with the Cornell Agricultural Experiment Station. Several strains of high-yielding power for different districts in New York State have been developed and are now being grown by cooperating farmers in the districts to which they have been found adapted.

BARLEY.

Trebi, a 6-rowed barley, originated in cooperation with the Idaho Agricultural Experiment Station by selection from a mixture obtained in Asia Minor, has been found especially well adapted to conditions, both dry land and irrigated, in southern Idaho, where its commercial production was begun in 1918 and now totals about 3,000 acres.

The Sandrel variety, produced in cooperation with the Minnesota Agricultural Experiment Station by selection from a Californian barley obtained originally in Moravia, has given excellent results and has been distributed to agricultural experiment stations for further trial in order to determine its range of adaptability.

Barley breeding with definite reference to the inheritance of several important characters, such as awns, adherent hulls, color of kernels, and size and shape of embryo is under extensive investigation in cooperation with the agricultural experiment stations of Idaho and Minnesota.

VELVET BEANS.

The rapidly increasing importance of velvet beans in the South is perhaps the most striking agricultural phenomenon of recent years. It is due primarily to the development of new early-maturing varieties. A recently evolved variety, the Bush velvet bean, is entirely

nontwining in habit, thus paralleling a similar phenomenon which has before occurred in the garden bean, the Lima bean, the cowpea, the soy bean, and other annual beanlike plants. Of the numerous hybrids developed by the Bureau of Plant Industry one that has been called the Mississippi velvet bean is so promising that it is being propagated for general distribution.

SOY BEANS.

Interest has continued to increase throughout the country relative to the utilization of the soy bean, not only for forage purposes, but for oil and food products. The introduction of new varieties by the Bureau of Plant Industry has greatly extended the production area of the crop and therefore has brought about a greatly increased acreage, especially northward and westward.

The field work has been extended in testing out improved sorts in various sections of the country. A large amount of selection and hybridization work has been done, resulting in several quite promising sorts. Nearly all of the varieties now handled by growers and seedsmen were originated by the Department of Agriculture. During the past year the Mandarin has been introduced in the North as one of the most promising early-grain sorts. For the lands of the South infested with the wilt and nematodes the Laredo has been found highly resistant and is one of the most promising forage sorts.

The Biloxi, Virginia, Black Eyebrow, Manchu, and Wilson-Five varieties have been distributed over a wide territory and have given excellent results. The testing of varieties for food has determined that the Hahto for a green vegetable and the Easy Cook, a soft-boiling sort, as a dried bean are the best. The Hahto especially has been received with considerable favor. It has been widely distributed, several thousand packets being given to the boys' and girls' canning clubs of the South. In addition to developing forage and food value, breeding work has been conducted with varieties for high content of oil and protein.

TIMOTHY.

The new strains of timothy developed at Elyria, Ohio, at the forage-crop testing station, in cooperation with the Ohio Agricultural Experiment Station, still continue to prove superior to common commercial timothy in both pot and field tests. Investigations are now being carefully conducted with a view to solving some of the practical difficulties that lie in the way of establishing these strains in general use throughout the important timothy-growing sections of the country.

NEW CROP PLANTS AND CROP EXTENSION.

EGYPTIAN COTTON IN CALIFORNIA.

Many fields of Egyptian cotton were grown around Fresno and Bakersfield, Calif., in the San Joaquin Valley in 1918 and afforded striking demonstrations of the possibility of extensive production in this region. Not only were good yields obtained at the rate of a bale per acre, but the plants also showed an unusually regular and full development of the fruiting branches and bolls during the entire

season. Abortion of fruiting branches, buds, and bolls early in the season was much less common than in the Imperial and Salt River Valleys, and there was less injury from drought or other extreme conditions that often reduce the yields or impair the quality of the fiber in the southern valleys. In view of such differences of behavior there seems to be no ground for the fear that the growing season in the San Joaquin Valley may prove too short for Egyptian cotton.

WHEAT.

Early Baart, a hard white wheat, fields of which were surveyed in Arizona and California in 1918, was again grown on an increased scale in those States in 1919. Most of the expansion was based on seed from inspected fields. The results of this enlarged acreage are reported to be excellent.

The production of Dicklow, a white wheat of good quality, is being encouraged on the irrigated farms of the Snake River Basin in Idaho. A considerable extension of acreage took place in the spring of 1919, the total being about 8,000 acres, and excellent results are reported where sufficient irrigation water was available.

A selection of Dawson Golden Chaff wheat, resulting from cooperative experiments at the Cornell Agricultural Experiment Station, is now being distributed rather rapidly in New York State. The commercial fields of this variety are inspected each year in order that only pure seed of high quality may be used for the increasing acreage.

Kanred, a hard red winter variety, originated at the Kansas Agricultural Experiment Station, was inspected in commercial fields in Kansas in 1918, and some 400 fields of this variety were inspected by State officials in 1919. It is likely to become increasingly popular because of its resistance to leaf rust and stem rust, as well as because of its productiveness and high quality.

OATS.

The Albion and Richland, two superior early oat varieties, developed in cooperation with the Iowa Agricultural Experiment Station, are grown on an increasing acreage in Iowa and the adjacent States in the oat belt. The Albion (Iowa No. 103) is a selection from Sixty-Day. It is estimated that fully a million acres of it were grown in Iowa this year. The Richland (Iowa No. 105) is adapted to the more fertile alluvial soils, on which it yields about 4 bushels per acre more than the Kherson oat, from which it was developed. It is estimated that at least 50,000 acres were grown in Iowa in 1919.

Improved selections produced in cooperation with the Cornell Agricultural Experiment Station have been distributed commercially in cooperation with selected farmers, and their use is increasing in those sections of the State to which they are especially adapted.

BARLEY.

Owing to the decreasing demand for barley incident to the termination of the war and the advance of the prohibition movement, and owing further to the guaranteed price of wheat, it was feared that there might be a tendency to decrease the barley acreage in the

spring of 1919. Barley is a very important crop in the rotation in the States of the northern Mississippi Valley, as well as a very valuable crop for stock feeding. Active measures were taken in Wisconsin and Minnesota, especially, to emphasize the value of barley to the farmers of those States and thus encourage continued production.

RICE.

In California the commercial acreage of varieties introduced and improved by the Bureau of Plant Industry represented over 20 per cent of the total area of 106,220 acres in 1918. In 1919 this percentage is believed to be still larger.

GRAIN SORGHUMS.

Owing to the importance of the grain sorghums as drought-resistant crops, and in view of the long-continued droughts which have occurred in the western portions of Kansas, Oklahoma, and Texas during the past two or three years, another campaign was carried on in those States in the spring of 1919 to emphasize the value of these crops. The resulting acreage, while below that of 1918 because of the enormous increase in wheat, is slightly larger than that of 1917 and more than a million acres larger than that of 1916.

WINTER FLAX.

Under the supervision of a specialist, commercial sowings of winter flax were made for the first time in Arizona and southern California in February and March, 1919. These have now been inspected and harvested under supervision, and the seed either has been reserved for seeding an increased acreage next winter or arrangements have been made for shipping it to an oil mill, where its quality for oil production will be determined.

HARD FIBERS FOR BINDER TWINE AND CORDAGE.

The continued uncertainty of supply and the threatened shortage of henequen from Yucatan have caused serious anxiety lest there might not be enough binder twine to harvest the increasing crops of grain in this country. Investigations have been continued, therefore, with a view to finding new sources of supply or new regions where binder-twine fibers may be produced.

Field investigations have been conducted in southern Florida, Cuba, Haiti, Santo Domingo, Porto Rico, and the Virgin Islands.

HENEQUEN AND SISAL.—The conditions in extreme southern Florida and on the larger keys are regarded as suitable for the production of sisal and henequen fibers, provided the cost of land and of labor there is not too high to permit successful competition with other regions where these fibers are produced. A large commercial plantation is now being established by private capital in that region.

Henequen has been cultivated successfully for several years in Cuba, and the plantations are being increased there, but thus far they produce scarcely enough fiber to supply the cordage mills on that island.

In the Republics of Haiti and Santo Domingo it was found that most of the plants heretofore referred to as sisal or henequen were other species of agaves or furcracas, which had been misidentified. Conditions are regarded as favorable for the production of binder-

twine fibers in limited areas in Haiti and over a much larger area in southern Santo Domingo. A small experimental planting of sisal has been made near La Romona, Santo Domingo.

In Porto Rico experimental plantings made in former years have resulted in the establishment of a commercial plantation near Yauco. Trial plantings of both sisal and henequen near Quebradillas, in northwestern Porto Rico, and on Mona Island, about 40 miles west of Mayaguez, are making a promising growth.

A fiber-cleaning machine of commercial type has been sent to the experiment station at Mayaguez, P. R., to demonstrate the production of henequen and sisal.

The development of improved strains of henequen and sisal by means of selections begun in 1917 at Mayaguez is being continued. Many of the second generation of suckers have been set out, and bulbils from the original selected plants which have sent up flower stalks are being grown in nurseries. The cultivation in several instances of bulbils and suckers from the same parent plant is expected to furnish more definite information than has been available heretofore regarding the relative merits of these two sources of propagating stock.

In the Virgin Islands excellent conditions for the cultivation of sisal, and probably henequen, are found on St. Croix, and there are now growing on that island sisal plants with leaves nearly 6 feet long that may furnish stock for starting a plantation.

In the Philippines the cooperation of the Bureau of Plant Industry with the Philippine Bureau of Agriculture in demonstrating the preparation of sisal fiber by means of modern fiber-cleaning machines has resulted in an increased planting of sisal on those islands and in the purchase and installation of machines by private capital to develop the sisal industry on a larger scale. The Philippine maguey plants are being replaced by sisal plants, which yield a fiber better adapted to the requirements of American manufacturers.

PHORMIUM, OR NEW ZEALAND HEMP.—The fact that phormium fiber may be used for binder twine and, furthermore, that this is the only cultivated hard-fiber plant which is grown in the Temperate Zone has led to an insistent demand for investigation to determine whether it may be grown profitably in the United States. The information obtained thus far shows that phormium is cultivated to only a very limited extent in New Zealand, most of the fiber being obtained from plants growing wild in reclaimed swamps. It has been introduced into nearly all warm or subtropical countries, but only on the island of St. Helena has the production of its fiber become an established industry, and in no place has it been found to grow in areas of commercial size as luxuriantly as it does in its native country. Several attempts by private individuals to cultivate phormium in this country have resulted in failure. These failures, however, together with the more successful growth of individual plants cultivated for ornament, have demonstrated that phormium requires a climate free from extremes of heat or cold, abundant moisture, and a fertile soil well supplied with humus.

Seeds of phormium have been secured from New Zealand, and young seedlings have been set out under conditions as nearly as may be found meeting the requirements of the plant.

YUCCA FIBERS.—An investigation has been made of the production of fiber from leaves of yucca plants growing abundantly over hundreds of square miles of unused lands from western Texas to southern California.

Fibers from palmilla (*Yucca elata*) in southern New Mexico and bear grass (*Yucca glauca*) in northeastern New Mexico and adjacent parts of Texas, Oklahoma, and Kansas have been used as emergency supplies to take the place of jute in the manufacture of cotton bagging.

Coarser fibers, more nearly like palma ixtle in character, are being prepared from the leaves of the blue yucca (*Yucca baccata*) of northern Arizona and eastern California, the green yucca (*Yucca mohavensis*), extending from the Mohave Desert of California to central Arizona, and the flowering yucca (*Hesperoyucca whipplei*), growing in the San Bernardino and Coast Range Mountains of California, to be used in the manufacture of binder twine.

The yucca plants now growing are sufficient to insure a supply of leaves for several years, but investigations are desired to determine the rapidity of growth, length of life, and the possibility of cultivating a permanent supply.

SOFT FIBERS FOR THREAD AND TWINE.

The severe reduction in foreign supplies of flax and hemp has resulted in increasing interest in the production of these fibers in the United States. The principal efforts of the Bureau of Plant Industry to encourage the cultivation of hemp and fiber flax in the United States have been directed toward the development of improved strains or varieties.

FLAX.—A large number of pedigree selections of fiber flax and also increase plats of the best varieties were grown at the experiment station at East Lansing, Mich., in 1918. These improved strains had been developed by four to eight generations of selection. A marked difference in resistance to lodging was shown by the different strains, and it was noted that some of the tallest and best strains were also lodge resistant.

In order to gain time in increasing the supply of seed of these improved strains some of the seed, after being harvested in Michigan, was taken to Porto Rico, where an increase crop was grown during the winter. The seed thus produced was brought back in the spring of 1919, in time for planting semicommercial tests in the fiber flax-growing regions in Michigan and Oregon. This flax is decidedly superior to the fiber flax grown from commercial seed of either recent or remote importation. The stocks of these improved strains are being increased as rapidly as possible.

Trial plats of fiber flax, ranging from one-tenth acre to 5 acres, are being grown in 12 localities in Wisconsin. Some of these plats are very promising, notwithstanding unfavorable weather conditions.

In addition to eastern Michigan and the Willamette Valley in Oregon, where the cultivation of fiber flax has become an established industry, this crop is being cultivated this season in western Washington, southeastern Minnesota, southern Wisconsin, and western

New York. The total area, about 5,000 acres, is slightly in excess of that of 1918.

HEMP.—The plats of pedigree seed hemp at the Arlington Farm made a record growth in 1918, two of the best varieties averaging 13 feet 5 inches and 12 feet 5 inches, respectively. More than 600 pounds of seed of these pedigree plants were sent out to commercial growers. Some of this was sown broadcast for fiber in order to compare it with commercial crops, but more than 300 acres were planted with this seed in checks for seed production, and this should yield enough for more than 4,000 acres of fiber hemp next year.

The second-generation hybrid Ferramington, combining the height and long internodes of Kymington with the earliness and heavy seed yield of Ferrara, gives promise of a good fiber type of hemp that may ripen seed as far north as Wisconsin.

A foreign market for American hemp is being developed, and for the first time in more than half a century commercial shipments of hemp grown in the United States are being sent to Europe.

Two important needs of the hemp industry in this country at the present time are an efficient system of water retting which will produce high-grade fiber like that imported from Italy and a satisfactory system of grading, so that both the producer and the manufacturer may know the quality of each bale of fiber.

FORAGE CROPS.

RHODE ISLAND BENT.

The preliminary tests of a new stripping machine to harvest the seed of Rhode Island bent were very satisfactory. Extensive tests will be conducted, and it is confidently believed that this machine will insure adequate market supplies of this seed, for which there is a large demand.

NAPIER GRASS.

Napier grass has created great enthusiasm equally in the extreme South and in California. In Florida it is more productive on sandy soils than any other grass yet found. The possibility of utilizing it as a pasture crop by grazing separate fields when the grass is 18 to 24 inches high is being tested; also the practicability of ensiling it when 6 to 8 feet high, two such crops being produced in a season. The mature stems are too fibrous to be satisfactory as feed.

SEEKING NEW CROP PLANTS ABROAD.

The search for new crops in foreign countries was continued during the year. This work was necessarily curtailed on account of war conditions. Explorations in Ecuador resulted in securing something like 50 new plant immigrants, among which are two avocados from a high altitude which may prove cold resistant. Through foreign correspondence something like 1,000 new plant immigrants were introduced. The search for new and promising crop plants was continued in a limited way in China and Japan.

NEW AVOCADOS FROM GUATEMALA.

Twenty-three new and promising avocados have been secured from Guatemala. More than 4,000 of these have been propagated, freed

from dangerous insects and diseases, and distributed for tests in Florida, California, Hawaii, Porto Rico, and Cuba. The varieties introduced should have a wide range, as they represent types coming from near sea level up to an altitude of more than 5,000 feet.

BAMBOO AS A CROP FOR THE SOUTH.

Sufficient progress has been made in the growing and testing of bamboos to show that we now have six or seven types suitable for a wide range of soil and climate and useful for a great variety of purposes. A type suitable to the warmer parts of the United States has been found useful in the manufacture of several kinds of brushes and brooms. A valuable edible type has been obtained and is being propagated. Two of the types adapted to a wide range of soil and climate have been found useful in the manufacture of fancy fishing poles and phonograph needles. Prior to the war, large importations of canes were made from the Orient for these purposes. The greatest use for the bamboo in the South will, it is believed, come from home utilization for water pipes, poultry-yard fences, poultry protection, light fences and gates, simple types of home furniture, outbuildings, etc. Bamboos are being propagated extensively with a view to inaugurating plantings and making tests through cooperation with boys' and girls' pig and poultry clubs in the South.

NEW OR RARE FORAGE CROPS.

Something like 1,200 bushels of new and rare soy-bean seed were grown for special distribution. The Hahto soy bean, introduced in 1915, has proved a most useful food and forage crop. An extensive distribution of this bean has been made in order that it may be given a thorough trial.

NEW STOCKS FOR AMERICAN FRUIT GROWERS.

One of the big problems of American fruit growing is that of stocks resistant to diseases and insects and suitable for our wide range of soil and climate. Promising new stocks of pear, apple, peach, cherry, and plum have been assembled from foreign countries, chiefly the Orient. Nearly 150 pounds of seed from pear trees supposed to be resistant to fire-blight have been secured through exploration in China. Seedling stocks are being grown at widely separated places, and distributions are being made to nurserymen and others in order to determine their disease resistance, congeniality, and adaptability to varying soils and climates. About 75,000 new pear stocks have been distributed.

BLIGHT-RESISTANT CHESTNUT TREES.

The Chinese chestnut (*Castanea mollissima*) has been found one of the most promising trees to combat disease. This chestnut was found in China, where for years the trees had to struggle against blight. Several thousands of these young trees are now being grown, also several thousand hybrid chestnuts, with the object of testing them for disease resistance and nut production.

PROMISING NEW VEGETABLE CROPS.

The dasheen continues to offer encouraging possibilities as a food crop for the South. Special attention was given to the marketing of this crop during the year. Nearly all the dasheens were marketed in northern and eastern cities, the price ranging from 12½ to 20 cents per pound. Seed tubers were supplied to about 1,700 collaborating experimenters. The production at one station on 3 acres was 850 bushels, or something over 50,000 pounds.

The chayote, another vegetable, gives promise of success. Nearly 750 bushels of this crop were produced at two stations, and 1,075 packages were sent to home demonstration agents in the South and to cooking schools. Something over 1,700 packages of seed chayotes were sent to persons in the South Atlantic and Gulf States who wish to grow the vegetable experimentally.

The arracacia, a staple vegetable of the Venezuelans, is another promising vegetable for the Southern States.

PROTECTING NEW PLANT INTRODUCTIONS.

So many dangerous and destructive crop enemies have been brought into this country that public sentiment has demanded more thorough protection. Very rigid protective measures have been adopted in connection with all plant-introduction work conducted by the Bureau of Plant Industry. Not only is every safeguard taken to prevent dangerous enemies from coming in on plant immigrants, but every precaution is observed in freeing our own seeds and plants which we send to foreign countries from many potential enemies that might be injurious in their new homes. Cooperating with the Federal Horticultural Board, intensive inspection is made of all seeds and plants coming from foreign countries and all seeds and plants distributed from our stations but originally coming from abroad. Between 3,500 and 4,000 lots of seeds and plants coming into the country and going out of the country were examined the past year. The increase in this work under the new Quarantine Order No. 37, issued by the Federal Horticultural Board, has made it necessary to broaden its scope. To this end a new plant-detention station is being established near the city of Washington. This station will have for its primary object the receiving and growing of new plant immigrants with a view to removing all possible chances of introducing dangerous diseases and insect enemies.

CROP UTILIZATION.

DRUG-PLANT INVESTIGATIONS.

Notwithstanding the prevailing high market prices of crude botanical drugs, the period covered by the past fiscal year has been a critical one as affecting drug-plant culture in this country, because of shortage of labor and unexpected difficulties encountered by many who engaged in the enterprise without the experience or knowledge necessary to carry on the work successfully. The net result is seen in the abandonment of the work by a large number of the smaller growers, leaving the field to those who have been reasonably successful, either through favorable location or better equipment, from

the standpoint of facilities for handling special crops and business organization for marketing the products. The Bureau of Plant Industry has continued its efforts to assist both in the permanent development of this industry along practical lines and in saving waste and unproductive effort in directions likely to result in failure.

Continued interest is manifested in the development of drug gardens at schools of pharmacy throughout the country, and in a number of instances material assistance has been rendered in connection with the establishment of new gardens by furnishing plans, supplying seeds, roots, and plants for propagation, and giving desired information with respect to suitable selections for the available situation and general methods of culture and handling. This feature of the development of drug-plant culture affords improved facilities for instruction in the characteristics and properties of medicinal plants, and further is calculated to conserve propagating stock of important medicinal plants in this country and disseminate practical knowledge concerning drug-plant growing and handling.

THE CAMPHOR INDUSTRY.

The high price of camphor and the difficulty of obtaining adequate supplies from the native sources of production have greatly stimulated interest in the development of the camphor industry in Florida. Through an informal cooperation with the large camphor growers systematic observations have been continued on improved methods of growing and handling the crop in the field. An intensive study of the process of distillation revealed sources of loss, and refinements in the methods of recovery were devised by which the percentage of camphor recovered from the distilled material is very substantially increased. Extended experimentation on methods of propagating and transplanting camphor seedlings has resulted in a substantial reduction in the cost of these operations on a large acreage basis.

UTILIZATION OF AGRICULTURAL WASTE PRODUCTS.

Studies of waste materials of the canning and fruit-packing industries have been continued with reference to the economic possibilities in the recovery of valuable commercial products from these sources. Investigations of the utilization of tomato-cannery waste on a commercial scale have been brought to satisfactory completion. Similar studies during the year have included the investigation of the possibilities in the utilization of waste grape pomace, pumpkin seed, and corn waste from canneries, and the sirup content of the stalks remaining after the harvest of sweet corn.

CROP UTILIZATION IN IRRIGATED REGIONS.

In newly developed irrigated regions there is a continuing and urgent demand for information as to the best varieties of field crops for each locality and the best methods of culture, as well as of methods of crop utilization.

The economic importance of utilizing bulky forage crops at the point of production through the use of live stock has been fully recognized, and arrangements have been made for demonstrating at the irrigated field stations the most efficient methods of using such crops. Extensive demonstrations have been carried on in pasturing

crops, the production of silage crops, the utilization of by-products, and in supplementing pasture crops with grain for the production of meat and milk. Some attention has also been given to the use of sheep on irrigated farms, and some of the possibilities of using these animals for consuming waste products and cleaning up fields and ditch banks have been demonstrated.

INVESTIGATIONS OF SEED SUPPLIES.

ENFORCEMENT OF THE SEED-IMPORTATION ACT.

During the past year comparatively few lots of seed have been offered for entry which did not comply with the requirements of the Seed-Importation Act. The most striking exceptions have been certain lots of Canadian alsike-clover screenings which have been imported for the purpose of recleaning.

Of those seeds covered by the act the importations during the fiscal year 1919 have been few as compared with 1917 and the preceding year, with the exception of alsike clover, of which 7 million pounds were imported, as compared with $3\frac{1}{2}$ million pounds last year and $4\frac{1}{4}$ million pounds the previous year, these three years being those of largest importation of this kind of seed. It is evident that practically this entire quantity of alsike-clover seed was put into consumption, so there will be little, if any, carry-over of the seed imported during the fiscal year.

There was a remarkable falling off in the quantity of rapeseed imported—639,000 pounds this year as compared with more than 11 $\frac{1}{4}$ million pounds last year, both years' importations coming principally from Japan.

SEED TESTING.

During the year, 18,820 samples of seed were received for test at the Washington laboratory and 10,252 at the five branch laboratories maintained in cooperation with State institutions.

LABELING FIELD SEEDS.

Following a conference with seedsmen in the summer of 1917, representatives of the seed-trade associations and a large number of individual seedsmen agreed to label all lots of field and forage-crop seeds sold in quantities of 10 pounds or more with the percentage of pure live seed, the date of the germination test, and in certain cases the country of origin. In the spring of 1918, seeds of redtop and red clover were purchased and examined to determine to what extent this agreement was kept. This examination showed that only 10 per cent of the lots of seeds purchased were found to be fully labeled in accordance with the agreement.

Practically all of the larger seed dealers now have facilities for testing seeds and know the quality of the seeds they are handling, but apparently most of them are not passing on to the farmer this information, which is of vital importance to him.

CRIMSON CLOVER.

A series of trials designed to be carried on for five years has been begun to determine whether French or domestic crimson-clover seed is best for this country. These trials are being made in coopera-

tion with the Delaware and North Carolina agricultural experiment stations. The seed used comes from France, Italy, Delaware, and Tennessee.

In connection with the development of the crimson-clover seed-growing industry in south-central Tennessee, a preliminary study has been made of the problems and it has been found that harvesting is the most important one connected with this project. The tendency of the growers is to harvest a little too early, so as to prevent loss by shattering. This results in harvesting a great deal of shrunken immature seed. Work must be done to determine whether harvesters can be used that will permit the clover to stand until thoroughly mature.

COTTON.

The selection and the distribution of superior varieties of cotton are being continued, with special attention to the problem of developing and maintaining adequate supplies of pure seed in order to extend the commercial production of these varieties in the different regions of the cotton belt. The largest volume of production has been attained with the Lone Star variety, now estimated at above 1,000,000 acres. This variety represents the Texas Big-Boll type, having the good qualities of Triumph and Rowden with larger bolls and lint of better quality, that under normal market conditions commands a distinct premium over ordinary short cotton. The Lone Star variety has been distributed eastward from Texas, with the advance of the boll weevil, and has become popular in many Upland districts. An organized production of larger quantities of pure Lone Star seed is being developed in northern Texas, with a cotton-breeding station at Greenville, Hunt County, serving as a center for cooperation with local communities.

The Trice cotton has become widely known, being an extra-early variety, unusually productive, and having larger bolls and better lint than other short-season kinds. It is grown especially along the northern rim of the cotton belt. For dry weather and short-season conditions in Oklahoma and Texas a variety recently acclimatized from southern Mexico is being grown extensively under the name of Acala.

Several long-staple Upland varieties have been bred or acclimatized and distributed by the Bureau of Plant Industry and grown in commercial quantities, the Columbia (or Webber) in South Carolina and adjacent States, the Foster in Louisiana and the Red River Valley of Texas, and the Durango in the Imperial Valley of California, the Pecos Valley of New Mexico and Texas, and also in Alabama and South Carolina and in southeastern Virginia. Another new type called Kekchi, introduced from Guatemala several years ago but not yet distributed, has attained local popularity in northern Texas, around Clarksville.

Between two and three thousand acres of Meade cotton are being grown this season in the Sea Island district of Georgia and Florida. This variety seems likely to replace entirely the mainland crop of Sea Island cotton as soon as the seed can be multiplied in sufficient quantity. The production of pure Meade seed is still inadequate to meet the demands, since it has been demonstrated that the variety

is not only as early as most of the short-staple varieties, but yields well and produces a fiber that is received on the markets on a par with Sea Island cotton; in fact, many bales of Meade have commanded a premium over Sea Island. The supply of pure seed for planting purposes is being rapidly increased, due to the cooperation of many growers who have appreciated the necessity for isolation and clean ginning. It has been found, however, that many growers and ginners do not appreciate the necessity for pure seed, and quantities of mixed seed have been sold and planted. Should this process continue, the reputation of the Meade variety for uniformity may suffer on account of the distribution of these mixed stocks. An organization of Meade growers in cooperation with the Bureau of Plant Industry is endeavoring to have all mixed stocks replaced with pure seed, and with a definite recognition of the need of continued selection and isolation to maintain the purity and uniformity of the stock it is hoped that the necessary precautions may be taken.

The most striking example of introducing a new type of cotton, establishing a new industry, and maintaining an adequate supply of good seed is in connection with the Pima variety of Egyptian cotton in the Salt River Valley of Arizona. Nearly 100,000 acres of pure Pima cotton were planted in the spring of 1919 in the irrigated districts of the Southwestern States. This scale of production of superior fiber has become possible through the establishment of a central supply of pure seed, 1,250 tons being furnished for planting in 1919 from a single community center around Tempe, Ariz., where no other variety is grown.

Cooperation with the Pima cotton growers in maintaining the purity of their planting seed was continued by roguing the seed-increase fields and removing the off-type plants. This work gives an exceptional opportunity for thorough study of the commercial seed stock of this variety and for detecting the first indication of deterioration, if this should occur. No evidence has yet been obtained of any loss of uniformity in this variety. The measures taken by the Bureau of Plant Industry, ably seconded by a growers' association in the Salt River Valley, have successfully protected this exceptionally uniform cotton from mixing or crossing with any other variety.

Pima cotton is now the only very long staple variety (with fiber $1\frac{3}{8}$ to $1\frac{3}{4}$ inches long) grown in the United States of which a large supply of even-running fiber is obtainable. Approximately 35,000 bales were produced in Arizona and California in the calendar year 1918. The demand for this variety since Sea Island cotton production has been curtailed by the boll weevil has exceeded the supply. This cotton is most extensively used in high-grade automobile-tire fabrics and appears to be a satisfactory substitute for Sea Island in most goods for which that cotton is used.

A serious problem of cotton farming in dry regions or where dry weather occurs at the planting season is to obtain regular germination of seed and a full stand of plants in the rows. Germination may be prevented by dry soil or by planting too deep. Experiments conducted in Arizona and Texas have shown that much better stands can be secured by a lister attached to the shoe of the planter, which makes it possible to place the seed in moist soil at a uniform depth.

CONGRESSIONAL SEED DISTRIBUTION.

During the fiscal year 1919 there were distributed on congressional and miscellaneous requests 8,072,791 packages of vegetable seed, and 883,136 packages of flower seed, or a total of 8,955,927 packages, each containing five packets of different kinds of seed. There were also distributed 12,122 packages of lawn-grass seed, and 10,368 packages of imported narcissus and tulip bulbs. The seeds and bulbs were purchased on competitive bids, as heretofore. Each lot of seed purchased was thoroughly tested for purity and viability before acceptance by the Bureau of Plant Industry, and tests of each lot of seed were conducted on the trial grounds of the Department of Agriculture to determine its trueness to type.

NEW AND RARE FIELD-SEED DISTRIBUTION.

A distribution of new and rare field seeds was made throughout the entire United States, having for its object the dissemination of seed of new and rare field crops, seed of improved strains of staple crops, and high-grade seed of crops new to sections where the data of the Department of Agriculture indicate such crops to be of considerable promise. Each package contained a sufficient quantity of seed for a satisfactory field trial, and the recipient was urged to use the seed, if feasible, for the production of stocks for future plantings. A report card and a circular giving full directions for the culture of the crop accompanied each package of seed.

Only seed of new crops or of improved strains of standard crops were distributed, including the following: Dakota-grown, Grimm, Kansas-grown, and Peruvian alfalfas; Great Northern field beans; yellow and white sweet clovers; Brabham, Groit, and Early Buff cowpeas; feterita; Bangalia, Carleton, Gregory, and Paragon field peas; Natal grass, orchard grass, and Rhodes grass; Dwarf Black-hull kafir; Turkestan, Golden, and Kursk millet; Dwarf Yellow milo; Freed, Dakota Amber, Red Amber, and Sumac sorghums; Biloxi, Black Eyebrow, Haberlandt, Ito San, Mammoth Yellow, Manchu, Peking, Tokyo, Virginia, Wilson, and Wilson-Five varieties of soy beans; Sudan grass; Alabama, Bush, Georgia, and Osceola velvet beans; purple, narrow-leaved, and woolly-podded vetch; and the Acala, Columbia, Dixie, Durango, Holdon, Lone Star, Meade, and Trice varieties of cotton.

During the year 139,441 packages of new and rare forage-crop seeds and 80,701 packages of cotton seed, or a total of 220,142 packages, were distributed. Gratifying results were obtained, indicating that by enabling a farmer to procure seed of new and improved crops in sufficient quantity to produce stocks for future seeding the crops of the country are gradually improved.

SOIL-FERTILITY INVESTIGATIONS.**FERTILIZER STUDIES IN THE FIELD.**

Field studies have been continued and much extended during the year, and the results obtained have been particularly timely, in view of the fact that the war has upset the normal fertilizer composition and practice with regard both to nitrogen carriers and to potash

carriers. Field experiments have been conducted on the Washburn and Caribou silt loam in Maine; on the Sassafras silt loam on Long Island and in New Jersey; on the Penn loam in New Jersey; on the Hagerstown loam in Pennsylvania; on the Norfolk fine sandy loam in Virginia, North Carolina, South Carolina, and Florida; on the Norfolk sandy loam in Florida and the Norfolk coarse sandy loam in South Carolina; on the Portsmouth sandy loam in South Carolina; on the Coxville fine sandy loam in South Carolina; on the Orangeburg sandy loam in Georgia; on the Pope fine sandy loam in Arkansas; on the Greenville sandy loam in Georgia; on the Susquehanna fine sandy loam in Georgia; on the Scottsburg sandy loam in Indiana; and on the Superior silty clay loam at Ashland, Wis.

In the plan of experimentation followed there are being determined the best ratios of the plant-food constituents in the fertilizer mixture suited to the respective soils, the amount of these fertilizers giving the most profitable returns, and the availability of the various carriers for phosphate, potash, and nitrogen in the fertilizing materials commonly employed, as well as those which have been introduced during the war.

The American sources of potash studied are the salts from the Nebraska lakes, which are principally carbonates; the salts from the California borax lakes, which are principally muriates; the product from alunite mined in Utah, which is a high-grade sulphate of potash; ground kelp from the Pacific coast, tobacco stems, beet-waste potash, and several potash materials collected as dust from the cement mills. The sources of nitrogen studied are sodium nitrate, ammonium sulphate, dried blood, cottonseed meal, and cyanamid, a nitrogen-fixation product now used in fertilizers. The experiments are showing that these different materials have different economic importance, depending upon the soil and crop.

The crops grown in these fertilizer tests are those of greatest interest or economic importance to the region studied and include potatoes, cotton, corn, citrus fruits, pecans, sorghum, clover, celery, etc. These experiments are carried on cooperatively with the State agricultural experiment stations and other local associations and also with various offices of the department. The results obtained are being collected for a comprehensive study of these different soil types, but they are already yielding valuable results for local application as to the fertilizers best suited for particular regions and are also furnishing information to the farmers as to the various nitrogen and potash carriers most likely to produce the best returns in practice.

STUDIES OF THE MALNUTRITION OF CROP PLANTS.

The study of the malnutrition of certain plants, most notably of potato and cotton, which became particularly emphasized during the war, has been continued, and further facts regarding the distribution of these diseases and their relation to soil types, systems of agricultural practice, and fertilizers used have been determined. New and untried fertilizing materials are sometimes responsible for these troubles, but more often they have been due to an unbalanced condition in the fertilizers, due to too great an increase in one of the ingredients, with often total elimination of another. This in some regions has produced the so-called potash hunger of the potato plant,

to which considerable loss in the crop along the Atlantic coast can be ascribed. This unbalanced condition of the fertilizer shows itself most markedly on the low-lying soil regions of the East and on the sandier types of soil. A similar condition has shown itself along the Atlantic seaboard with the so-called cotton rust, which is a malnutrition disturbance caused by an unbalanced condition of the fertilizer used or by the unbalanced condition of the normal soil nutrient solution as found in many of the sandier soils of the Coastal Plain. The experiments show quite definitely that this condition is associated with the fertilizer practice and that potash salts will correct this difficulty and prevent the collapse of the plant.

To a certain extent last season and quite prominently this spring some further difficulties in fertilizer usage have arisen in connection with the reappearance of higher potash contents in fertilizers. This subject has been under investigation in connection with our tests on various potash sources now used in fertilizer practice, and the difficulty referred to appears to be due to a disturbance of the normal growth of the plants by the presence of borax in the potash-carrying fertilizers. Such fertilizers, it would seem, should be used only under such restrictions as will make it certain that harmful quantities of borax will not be introduced into the soil. The loss from this fertilizer disturbance this year is estimated to be considerable, especially when large quantities of a potash fertilizer are used, particularly with potatoes, cotton, and tobacco.

FERTILIZER TESTS OF UNUSUAL MATERIALS.

The war conditions have brought forth a very considerable number of substitutes for the usual and normal fertilizer ingredients, some of which are in the hands of various strongly organized concerns, but which are nevertheless of doubtful value. Quite a number of these products have been tested, both in the greenhouse and in the field, where either their worthless character or their proper value has been shown.

BIOCHEMICAL INVESTIGATIONS.

Scientific inquiries into the fundamental factors underlying soil fertility and plant nutrition have been continued and with the cessation of war work have developed at an increasing rate. Among these is the relation of certain plant diseases to the hydrogen-ion concentration of the soil; the study of the chlorophyll changes which occur in the case of malnutrition of the potato and cotton plants; the causes of certain chlorosis phenomena in plants under adverse soil conditions; the relationship of the composition of the crop to the fertilizers used; and the relationship of the soil in general to the prevalence of plant diseases and the physiological condition of the crop. There is in process also a study of the composition of the plant in certain constituents, such as proteins, carbohydrates, and fats, in relation to the fertilizer used.

UTILIZATION OF EXCESS WAR MATERIALS FOR FERTILIZER.

Since the close of the war an investigation into the use of deteriorated cannon powder and smokeless powder has been begun at the request of the War Department and in cooperation with the National

Research Council, with a view to utilizing economically such materials in fertilizer practice.

The investigation has already shown that trinitrotoluene is poisonous to plants and can not be directly used in fertilizers; that the nitrated celluloses, while not poisonous to plants, are, on the other hand, so insoluble as to leave the nitrogen unavailable to plants, and that ammonification or nitrification of this material in the soil proceeds with extreme slowness, if at all, under normal conditions. Chemical treatment of this material is therefore being resorted to, and already some very promising results have been obtained, which make the nitrogen of such materials available and would appear to be the basis for the possible utilization of such material in fertilizers.

FERTILIZER TESTS ON TOBACCO.

In Maryland a series of fertilizer tests with tobacco which has been in progress for several years was completed, and the results have been published in popular form. It has been found that on the average soil nitrogen is the fertilizer element most needed by the tobacco crop. Phosphoric acid has not increased the yield, but may improve the quality of the tobacco. Under systems of heavy or continuous cropping the tobacco has shown a decided need of potash. Under average conditions a fertilizer supplying 25 to 30 pounds each of nitrogen and potash and about 50 pounds of phosphoric acid per acre will give very profitable returns. The commercial fertilizers commonly used by tobacco growers do not furnish enough nitrogen for the best results. Field tests dealing with the fertilizer requirements of the principal types of tobacco were continued in the States of New York, Pennsylvania, West Virginia, Virginia, and the Carolinas.

Substantial progress has been made in an investigation of the rôle of potash in the nutrition of the tobacco plant, including the comparative effects of the muriate and sulphate on the growth and development of the plant. It has been established that there are material differences in the action of these two forms of potash when applied as a fertilizer to tobacco on certain types of soil.

PLANT-NUTRITION INVESTIGATIONS.

In the field experiments dealing with the specific effects of crop plants on the yields of crops immediately following, many data have been secured tending to show that under strictly comparable conditions corn, tobacco, and potatoes affect very differently the yields of succeeding crops of wheat, oats, and rye. These effects are manifested under different fertilizer treatments, but in varying degrees. The crops of corn, tobacco, and potatoes also show similar results when each crop is grown after itself and in rotation with the other two.

In connection with further investigations on the relation of the environmental conditions to the formation of oil in the seeds of plants it has been discovered that, contrary to general belief, sunlight, rather than temperature relations, is the important factor in determining the seasonal development or maturation of plants. This discovery of a comparatively simple connection between sunlight and the vegetative and reproductive phases of plant development un-

doubtedly will throw much light on the relationships between early and late maturing varieties and species and their natural distribution.

PLANT PHYSIOLOGICAL INVESTIGATIONS.

Evidence has accumulated that a low water requirement, although an important factor in comparative resistance to drought, is by no means the only factor involved. The water requirement has now been determined for practically all important species and varieties of field crops, and the data obtained during the past several years make it possible to answer decisively the question to what degree water requirement is correlated with adaptability to drought conditions. Attention was focused during the past year upon the increase and distribution, in cooperation with the congressional seed distribution, of improved strains of sorgo and millet adapted to conditions in the northern Great Plains region. Drought-resistance breeding work with other forage plants, especially alfalfa and smooth brome-grass, was continued, and promising strains of the two crops mentioned are being increased for distribution to farmers in the central and northern Great Plains.

CEREAL PATHOLOGY.

BLACK OR STEM RUST.

BLACK-RUST EPIDEMICS.—An intensive nation-wide investigation of black rust has been made during the year. Special attention has been given to the factors which may contribute to epidemics of this rust. Among these factors are weather conditions, soil drainage, air drainage, barberry bushes, the winter hardiness of the urediniospores, or red stage, and of the teliospores, or black stage, and the carrying of spores by the wind.

In the investigation of the overwintering of the black rust it has been found that survival varies with the severity of the winter. In average years very few of the red spores, which start the rust directly on wheat in the spring, are able to survive winter conditions north of about latitude 35° N. South of this general latitude, however, they were able to overwinter abundantly. In the exceptionally mild winter of 1918-19 they survived as far north as Wisconsin. On the other hand, the black spores, which start the rust on barberry bushes, normally live through even the severe winters of our most northern States and start the rust in the spring. They can not start the rust directly on wheat, however, so that destroying common barberries makes these spores harmless. A thorough investigation of the infection of wheat seed by black rust has been completed. The study has covered several years and involved the growing of many thousands of plants from rust-infected seed; no infection of seedlings from such infected seed has been produced.

Varieties of wheat almost completely resistant to some of the biological forms of black rust have been discovered or developed by breeding and are being used in other breeding experiments in cooperation with the agricultural experiment stations of Minnesota and Kansas.

BARBERRY ERADICATION.—The campaign for the control of the black rust of wheat through the eradication of the common barberry is in

active operation in thirteen North-Central States, namely, Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming. State laws requiring the removal of common barberry bushes have been enacted in all these States except Indiana, Ohio, and Wyoming. The campaign has been conducted in each State by widespread publicity through many channels.

The first problem, naturally, is to locate all bushes resulting from intentional planting and induce their owners to remove them.

The second, and perhaps the most difficult problem in the campaign, is to locate bushes running wild. The number of localities in which wild bushes are found is immensely larger than was believed at the beginning of the campaign. Through many decades since barberries were first planted in these States, the seeds have been sown in large numbers in thickets and woodlands by wild birds. The difficulty of locating such bushes in rough and broken timberland, oftentimes amid thickets and underbrush, will be appreciated by anyone who undertakes it. It is essential, however, that such bushes be located and removed. In most cases they are not far distant from grainfields, and in any case rust spreads readily from them to grainfields by way of wild grasses in their vicinity. Furthermore, if they remain undisturbed their numbers will continue to increase by the action of birds throughout the years to come.

The third problem is to insure that every bush located is removed by the owner or agent, and so thoroughly and completely removed that sprouts will not develop, or, failing this, to insure that sprouts which do appear will be destroyed.

Already the number of bushes located and destroyed runs into the millions. More than half a million have been destroyed by nurserymen in a single State. Naturally, as the campaign progresses the number of bushes located each month becomes smaller. However, they are still being found by the tens and hundreds of thousands. From March to July, 1919, inclusive, more than 16,000 bushes were located in Illinois. Nearly 40,000 were located in Iowa during the spring and early summer of this year. Up to May 30, 1919, Nebraska had found 63,000 bushes. About 94,000 plants have been removed from private premises in Wisconsin, in addition to large numbers taken out of public grounds. No serious outbreak of black stem rust occurred this season, although many bushes undoubtedly remain undiscovered.

LEAF RUSTS OF WHEAT, BARLEY, AND RYE.

A leaf-rust survey and investigation of epidemiology have shown the leaf rusts, and particularly the leaf rust of wheat, to be of far greater importance as limiting factors in grain production than had been supposed. In some sections of the South Atlantic coast the damage due to the leaf rust of wheat was so serious as to ruin the crop. In the States growing hard winter wheats extensively, such as Kansas, Nebraska, and Oklahoma, leaf rust was almost epidemic this season.

Field, greenhouse, and laboratory investigations of the leaf rusts of wheat, barley, and rye have been carried on in cooperation with

the Indiana Agricultural Experiment Station. Special studies to discover biologic forms of leaf rusts have so far given negative results. Considerable progress has been made in determining the hosts and host relationships of the several leaf rusts, and many data have been obtained on factors influencing the development of epidemics. Investigations have shown that the leaf rusts of wheat and rye can overwinter in the urediniospore stage, even in the severe northern winters.

One of the most important discoveries in the history of rust investigations in this country has been made in cooperation with the Agricultural Experiment Station of Kansas. The three Kansas wheat selections of the Crimean group—Kanred (P-726), P-1066, and P-1068—which previously were known to be resistant to the most seriously destructive biologic form of black rust, here proved to be highly resistant also to leaf rust.

FUSARIUM ROTS OF CORN AND THE SCAB OF WHEAT AND OTHER CEREALS.

Investigations show that the *Fusarium* rots of corn live through the winter both in the soil and in and on the seed. They attack the corn crop at several different stages and in several different ways, as follows: (1) By preventing germination in laboratory and field; (2) by causing a weak germination in the germinator and in the field; (3) by blighting and destroying the seedlings; (4) by dwarfing the seedlings so much that they develop only barren stalks or stalks with small and sometimes almost worthless ears; and (5) by rotting the root systems, or the stalks and ear shanks, resulting in stalks easily blown over by wind, in broken stalks, broken ear shanks, and the rotting of the ears themselves in varying degree. Some of the diseased plants ripen prematurely. Because of this early ripening, the ears from such plants frequently are selected for seed. Diseased stalks may bear undiseased ears, but usually plants grown from such ears are highly susceptible to attacks from the *Fusarium* rot fungi in the soil or elsewhere. The diseased ears can be largely excluded from seed corn by carefully selecting well-matured ears on healthy plants in the field and by special study of such seed on the germinator. Preliminary experiments show that by rejecting diseased ears the yields of corn may be materially increased, possibly as much as 10 or 15 or even 20 per cent in portions of the corn belt.

SIX SPECIES OF FUNGI MAKING THE PROBLEM COMPLEX.—Investigations to date indicate that there are at least six species and varieties of fungi which cause rots of corn, and one of these also causes scab, or blight, of wheat and other cereals. There are two important sources of infection for both corn and wheat—infected seed and old infected cornstalks; there may be still other sources of infection of wheat not yet determined.

TAKE-ALL AND FLAG SMUT OF WHEAT.

In April, 1919, the attention of the Bureau of Plant Industry was called to a serious outbreak of disease in the wheat fields of Madison County, Ill. Prompt investigation discovered a disease very similar to take-all, a very destructive disease of wheat in Australia and other parts of the Orient, as well as in some countries of Europe.

A few days later flag smut, a destructive disease of wheat in Australia, was discovered in wheat fields in the same county, and in some cases in the same fields as take-all. Pathologists of most of the wheat-producing States, together with a number from the United States Department of Agriculture, were immediately called together in Illinois in order to become personally familiar with these two diseases in the field. A survey of wheat fields, not only in Illinois but in many other States, was begun at once so as to determine whether one or both these diseases had become established elsewhere in this country. This survey resulted in the discovery of rather extensive infection in Madison County, Ill., with less extensive infection in two other counties in that State and in three counties in Indiana.

In cooperation with the Federal Horticultural Board and the authorities of Illinois and Indiana, action has been taken designed to prevent the spread of these two diseases and finally to eradicate them, if possible. The State officials have established quarantine areas, including the infested fields and the fields which surround them.

THE NEMATODE OR EELWORM DISEASE OF WHEAT.

The nematode disease of wheat has been found in Maryland, Virginia, West Virginia, and Georgia and has done considerable local damage. Investigation has shown that the disease attacks rye virulently; also oats, emmer, and spelt to some extent. Experiments have shown conclusively that the nematodes live over winter in the soil.

A wheat crop may become infected either from the seed or from the soil. To escape infestation, fields should be sown with seed wheat free from nematodes. Such seed wheat may be obtained either from uninfested fields or by treating wheat infested with nematode galls with a 20 to 25 per cent salt solution. In this brine the sound wheat will sink and the nematode galls will float, when they can be removed and destroyed. Experiments show conclusively that sowing seed wheat containing nematode galls without such treatment results in a heavily infected crop. Sowing clean seed wheat on infested soil also results in a serious infection of the crop, but clean seed wheat sown on clean land gives a clean crop, even though adjacent to infested fields.

CONTROL OF CEREAL SMUTS.

In the fall of 1917 a campaign was started, in cooperation with the extension services of the cereal-growing States, for the prevention of cereal smuts controllable by seed treatment. This work was continued throughout the fiscal year 1919. Demonstrations of methods of seed treatment were held in 28 States, a large number being given in each State. Departmental field assistants addressed groups of farmers and showed them the details of the methods of seed treatment. As a result there was a great increase in the quantity of seed grain treated in the last two years. Fully 25 per cent more farmers treated seed for the 1918 crop than for the crop of 1917. The results for the crop of 1919 are not yet compiled, but it is estimated that a still larger increase took place in the percentage of seed treated.

BLACK-CHAFF OF WHEAT.

Studies on the biology of the bacterial organism causing the black-chaff of wheat have continued, and numerous field observations were made on its distribution. It occurs in many places in Iowa, Kansas, Nebraska, and the neighboring States. This trouble is transmitted on the seed wheat, and wherever it is possible farmers are urged to procure seed wheat from fields which have not shown the disease.

A method of control by means of seed treatment has been discovered, which works remarkably well in the laboratory, greenhouse, and experimental plot, but is yet to be tried on a large scale under field conditions in the Middle West. This treatment consists in soaking the infected seed (after proper screening) for 10 minutes in formalin diluted with water in the proportion of 1 part to 400 parts of water. The former objection to the use of formalin, that either it did not kill all the surface organisms or else that it destroyed also a considerable portion of the seed, has been overcome by causing the seeds to absorb considerable water in advance of treatment. By giving the seed wheat a preliminary water bath for 10 minutes, after which it is drained and kept moist (covered) for six hours, the seeds absorb about 30 per cent of water and become much more resistant to the germicide. They are then plunged for 10 minutes into the formalin water, drained, and are kept moist (covered) for another six hours in order to secure the full surface effect of the small amount of formaldehyde vapor remaining. They are then spread out thinly to dry and should be sowed the next day.

CROP DISEASES.

POTATO DISEASES.

The investigations of potato mosaic, extending over several years, have yielded particularly valuable results during the past season in the way of proof of the means of dissemination of this disease and the possibilities of control through the roguing of seed plots. It has been shown that the mosaic is transmitted through stem grafts and tuber grafts, through transference of the plant juices mechanically, and by aphids. The establishment of these facts is an important step toward the working out of control measures for this disease.

Following the discovery in the fall of 1918 of the potato wart in the mining districts in the vicinity of Hazelton, Pa., the investigations already in progress were extended and enlarged. In cooperation with the Federal Horticultural Board and the Pennsylvania authorities a careful survey was made of the territory contiguous to the point where the wart was first discovered, and many gardens were found to be infested. A laboratory for the investigation of the disease has been established at Freeland, Pa., in cooperation with the Pennsylvania Department of Agriculture and the State Agricultural Experiment Station.

The studies of potato leaf-roll during the past year have included observations of the symptoms of this disease under varying conditions throughout the country. Our knowledge of this disease has been further increased through the results of comparative studies of the anatomy of healthy plants and those infected with leaf-roll.

WATERMELON DISEASES.

During the past season a special effort has been made to educate the southern grower in the methods of controlling the two most serious diseases of watermelons, anthracnose and stem-end rot. The Melon Distributors' Association, the United States Railroad Administration, and the State extension departments cooperated in this work. A field campaign was carried out, through which the methods for the control of these diseases were brought to the attention of the public by means of posters, printed cards, bulletins, and lantern slides. In the case of stem-end rot an effort was made to secure the stem treatment with disinfectant paste of all melons shipped from Georgia, Florida, South Carolina, and Alabama, the four States which have suffered most from this disease in the past. It is estimated that in 1918 more than 2,500 carloads of watermelons, almost 20 per cent of the total shipments from these four States, rotted in transit, the chief trouble being stem-end decay. The results to date of the inspection of cars treated this season show that the loss in these cars has been reduced to less than 1 per cent. A very general application of the stem treatment has been made possible by the fact that the United States Railroad Administration required the prepayment of the freight on untreated carloads.

Spraying for the control of watermelon anthracnose was also carried out this season under the supervision of our field assistants on approximately 3,400 acres of melons in Florida with satisfactory results. Tests of the practicability of seed treatment on a commercial scale for the control of watermelon anthracnose are being made on areas comprising about 2,000 acres in Indiana, Missouri, and Arkansas which have been planted with seed disinfected with mercuric chlorid.

CUCUMBER DISEASES.

The investigation of cucumber diseases, extending over several seasons, has yielded important results within the past year. Three of the most destructive and widespread diseases, mosaic, anthracnose, and angular leaf-spot, have received major attention. A prominent development in the study of the mosaic disease has been the discovery of a method of overwintering. The results of recent work have shown that a considerable percentage of seed from mosaic plants of the wild cucumber may produce diseased plants the following spring. In this way the first mosaic centers are established, from which the disease is later carried to the cultivated crop in the near-by fields by the striped cucumber beetle and other insects. Additional evidence has been secured that the disease is also carried over winter in the seed of cultivated mosaic cucumbers.

Continued studies of cucumber anthracnose and angular leaf-spot have proved that these diseases live over winter in the soil on dead diseased plants and other refuse and that they are also carried on the seed from infected fruits. A successful and practical method of seed disinfection by means of mercuric chlorid has been worked out and applied on a commercial scale, with successful results in the control of both these diseases when combined with proper rotation of crops.

TOMATO DISEASES.

Particular attention has been devoted during the past season to the control of early-blight, or nailhead spot, of tomatoes in Florida, which causes serious losses in shipments to northern markets. Laboratory and field studies have shown that infection by this disease can take place only on small immature fruit. After the fruit attains a size approximately 2 inches in diameter, infection, even under the most favorable conditions, is impossible. It follows, therefore, that loss from this disease in transit can be avoided by packing only sound and mature fruit and that control measures must be applied in the field. Preliminary experiments have shown that spraying with Bordeaux mixture is an effective means of control.

THE MOTTLING DISEASE OF SUGAR CANE.

There are several diseases of sugar cane that deserve special attention. Some of these, such as the root-rot and red-rot, have been known in this country for several years, but exact control measures have not been worked out. The malady most recently discovered in the cane fields of the United States is the mosaic or mottling disease, which has been known in Porto Rico for several years and has apparently existed in Cuba, Java, and Hawaii for a longer period. The cause is not known. It is propagated through the seed cane and probably is carried from plant to plant by one or more species of insects. The disease does not infect the soil and certain varieties of cane are immune to it. Of the susceptible varieties some are more readily and seriously affected than others. A systematic survey has been started in the cane States in order to determine the extent and seriousness of the infestation. It is known to be present on all susceptible varieties at Audubon Park and at Cairo. This disease, though very destructive, is not considered as serious as root-rot.

POWDERY MILDEW OF THE APPLE.

Apple powdery mildew has recently been causing great alarm among the apple growers in the irrigated sections of the Northwest. Complete control is usually secured by the application of sulphur sprays early in the season. When late applications are necessary, sulphur can not be used, as it is sure to cause injury. Various other spray materials are being tested for use late in the season.

SPRAY MIXTURES FOR CITRUS TREES.

The special spraying requirements of citrus trees have necessitated a comprehensive testing of combinations of spray materials. A method has been found for combining oil emulsion with lime-sulphur solution, and the resulting combined spray mixture gives promise of reducing the number of spray applications necessary and in increasing effectiveness in the routine treatment of citrus trees throughout the year.

NEMATODE INFESTATION OF CLOVER SEED.

Early in the summer of 1919 attention was drawn to the fact that a clover disease of considerable importance had visited southern Idaho and other irrigated districts of the Northwest. It was a

disease which had been previously known but evidently had been increasing in its intensity for several years. It had made such headway in the clover fields of Idaho in a short time as to lead to the suspicion that some unusual agency was at work. Attention was at once given to the possibility of the transmission of the disease through the seed, with the result that it was shown that clover seed, even when recleaned, carries a considerable number of nemas, and in the case of the Idaho seed in particular it was shown to carry four different species of nemas, one of them belonging to the genus *Tylenchus*, namely, the well-known *Tylenchus dipsaci*, or *Tylenchus devastatrix*, the cause of a serious disease of bulbous plants and about 20 other crop plants, among them red clover. A general examination disclosed the fact that some living larvæ of this particular species occurred in clover seed 9 to 10 months after it was harvested.

WHITE-PINE BLISTER RUST.

White-pine blister-rust infection on *Ribes* is general in the New England States and northeastern New York. Many widely distributed incipient pine infections are beginning to appear as a result of heavy *Ribes* infection in 1915 and 1916, but the disease has not yet had time to produce severe damage to pines on a large scale. Infested areas vary in size from a few pine trees within a hundred feet of infecting *Ribes* to 50 per cent of the pines within a radius of half a mile from diseased bushes.

It appears that in many regions the plan of protecting white-pine timber by the systematic eradication of *Ribes* will prove to be an economically sound policy.

In this campaign cooperation is maintained with the New England States and New York. The work is devoted almost entirely to perfecting cheap and effective methods of destroying wild *Ribes*, to practical demonstrations of these methods on local control areas, and to the encouragement of effective local eradication of *Ribes* in cooperation with towns, associations, and individuals.

Experience thus far gained on demonstration and local control areas has proved that under normal conditions at least 95 per cent of the wild *Ribes* on a given area can be removed at a cost ranging from 5 cents to \$1.50 per acre. It is too early to draw absolute conclusions as to the effect of *Ribes* destruction on the demonstration control areas during the past two years, but there is a noticeable lack of recent infection of pines on these areas, while on adjacent areas where *Ribes* have not been removed there is a steady increase in pine infection.

Intensive studies of infection centers have been made to obtain data as to the distance to which the disease may be carried from *Ribes* to pine. The limit of 1,700 feet, which is in use at the present time, is an arbitrary one, based on data now available.

Various chemicals and sprays are being tested in the hope of finding a cheap and practical means of killing wild *Ribes*. The results obtained indicate that dip oil, fuel oil, and possibly sodium arsenite can be used economically to destroy dense growths of *Ribes* where the cost of hand pulling is excessive.

The inspection of nursery stock and pine plantations and the general scouting for the disease on pine and Ribes are carried on in New Jersey, Pennsylvania, and the southern Appalachian region; also in the Middle and far Western States. Formal or informal cooperation is maintained with these States. One or two planted trees were found diseased last year in Pennsylvania, in Michigan, and also in New Jersey. In the last-named State the disease was also found on four patches of cultivated Ribes.

Scattered pine and currant infection exists in Wisconsin and Minnesota. It is not yet clear whether the complete eradication of the disease will be practicable in these States. The results of scouting in the far Western States indicate that this region is free from white-pine blister rust. Continued scouting in these States is most important and should be actively pursued during the period required for the solution of the Minnesota-Wisconsin infection problem.

CITRUS-CANKER ERADICATION.

The work of eradicating citrus canker from the citrus regions of the South is progressing steadily. No epidemic outbreaks of serious proportions have occurred during the year in any of the States affected, and a gradual reduction of inspection work has been possible without jeopardizing the eventual complete eradication of the disease.

REPORT OF THE FORESTER.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., October 8, 1919.

SIR: I have the honor to transmit herewith a report of the work in the Forest Service for the fiscal year ended June 30, 1919.

HENRY S. GRAVES,
Forester.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

THE EXTENSION OF FORESTRY PRACTICE.

The year covered by this report was signalized by a new movement for extending the practice of forestry. More than 20 years ago the Division of Forestry offered to give advice and assistance to private timber owners who might wish to consider applying forest management. The offer received a remarkable response and formed a real turning point in the forestry movement. For the first time forestry in the United States became something which a business man could grasp and weigh on its merits as a definite business proposal. This aided powerfully in bringing the whole question of forestry, public as well as private, before the country. But it did not result in any widespread acceptance of the practice of forestry by timberland owners.

The failure of this early movement to get private forests extensively under management was, however, not immediate. The Division of Forestry made its offer of cooperation early in the fiscal year 1898. By the close of the fiscal year 1905 requests had been received for the examination of private holdings, large and small, comprising all told more than 10,900,000 acres of land. Many requests were from lumber companies and other owners of extensive timber tracts. On the strength of the showing made by the preliminary examinations, a number of these large owners entered into cooperative agreements for the preparation of working plans. The interest of the lumbermen was much increased by the fact that the young foresters were able to show them that they were losing money by certain wasteful practices. Closer utilization spread rapidly through the industry. Public interest in forestry and an intelligent idea of what it meant became general. In the early years of the present century it really looked as though the management of forests as permanent productive properties might be voluntarily undertaken by private owners on a very large scale. Although many obstacles were presented by the internal conditions of the lumber industry, progressive lumbermen were giving much serious attention to the possibility of engaging in the practice of forestry. The chief stimulus was furnished by the rising value of stumpage.

The panic of 1907 radically changed the situation. The lumber industry entered a period of protracted depression. From that time on private forestry made relatively little progress in the United States, except on farm woodlands. While public forestry has made vast strides, the forests of the country that are in private hands are being depleted with very great rapidity, and almost everywhere without effort to renew them. A grave situation is becoming manifest in various ways. This is why the Forest Service is now putting forth a new and energetic effort to call public attention to the facts and to propose a program that will afford relief.

The problem presented is one that can be solved only by public action. The general practice of forestry on privately owned lands in the United States will not take place through unstimulated private initiative.

The magnitude of the National Forest enterprise and the prominence given to its accomplishments have given the impression to some that the problem of forestry is under way of solution. In point of fact, this is by no means the case, for the National Forests represent in area only about a quarter of the forest area of the country and less than that proportion of the actual standing timber. Private owners therefore hold more than three-fourths of the present timber supplies of the United States. The amount of materia which is actually placed on the market from the National Forests amounts to only about 3 per cent of the entire consumption of the country. The rest comes from private lands. While the proportion will be altered, the country must still look to private lands for a large part of its forest supplies.

The rate of depletion of our forest resources is more than twice, probably three times, what is actually being produced by growth in a form which will be servicable for products other than firewood. High prices of lumber are not wholly due to the increased cost of labor and materials. A part is due to the ever-retreating sources of timber supply. Already the supplies of all our eastern great centers of production are approaching exhaustion with the exception of the South, and even there most of the mills have not over 10 to 15 years' supply left of virgin timber. Already the southern pine is being withdrawn from many points as a competitive factor and its place taken by western timbers, with consequent freight charges which the consumer must pay. Communities needing to build roads and other public works which involve increased taxation are often having brought sharply to their attention the economic consequences of stripping off the forests and leaving in their stead unproductive wastes of low taxable value now or in the future. These facts are recalling public attention to the effects of uneconomic and wasteful exploitation of our forests in the past and to the need of steps which will put a stop to the destructive processes and replace them with methods which will build up rather than injure the country.

The situation necessitates a broad policy of forestry for the whole Nation which will include both an enlarged program of public acquisition of forests by the Government, the States, and municipalities and protection and perpetuation of forest growths on all privately owned lands which may not better be used for agriculture and settlement.

The proposed plan for realizing these objectives contemplates cooperation between the Federal Government and the States. The Government and the States must join hands in working out a program that will bring into correlation the various public and private efforts for the protection and right handling of forests. The function of the Federal Government, in addition to handling the National Forests, would be to stimulate, guide, and coordinate State action and conduct necessary investigations regarding the best methods of forestry, to assist the States in classification of land, and to harmonize action as between the different States. The States would also have a function in handling public property owned by them, and they would have a further direct responsibility in connection with the protection and perpetuation of private forest lands.

In the matter of private forestry the Government would work primarily through State agencies. To initiate the proposed policy there should be a Federal law authorizing the Government to cooperate with the States in bringing about the protection and right handling of forest lands within their borders, and providing means for such cooperation.

The net result of the steps already taken to inaugurate and organize the new movement for forestry has been to attract renewed and widespread attention to the fact that a real forest problem must be reckoned with, and is of national concern; to establish a conviction in the minds of many who have first-hand knowledge of the facts that definite action to protect the public interests involved and safeguard a resource essential for economic and industrial stability is now required; and to secure what is believed to be a feasible program, of a character to command general acceptance as it becomes fully understood.

PERSONNEL CHANGES IN THE FOREST SERVICE.

Since the signing of the armistice 419 members of the Forest Service have resigned. Of this number 118 were employed at the Forest Products Laboratory at Madison, Wis., 231 were members of the National Forest force, and 70 were employed in the District offices and at Washington.

The resignations at the Madison laboratory were mainly the result of curtailment of the activities there forced by large reductions in the funds supplied by the War and Navy Departments for lines of work which were a part of the war effort of the Nation. As set forth in last year's report, the Forest Products Laboratory had practically abandoned all other lines of work. When the armistice was signed the activities were at their peak. The field of public service of the laboratory was somewhat altered but in no way reduced by the sudden end of hostilities; but the supply of funds was progressively cut off. This was the chief cause of the reduction in force, though in a considerable number of individual instances men whom the laboratory wished to retain were lost because of the higher outside remuneration offered them.

Quite a different situation obtained with the National Forest force. Here the war had led to a curtailment of activities, the furloughing of many men who volunteered or were drafted for military service, the temporary or permanent withdrawal of other men to engage in

war work, and the carrying of heavier burdens by the men who were left. Generally speaking, the National Forest force sank personal considerations and recognized a patriotic duty to remain at their posts and exert themselves to the utmost to maintain through the period of the war indispensable activities, disregarding the opportunities very widely open to them to better themselves considerably in the matter of pay if they would accept outside employment. The National Forest organization, though subjected to a severe strain, was maintained intact because of the loyalty of its men to a high ideal of public service.

Since the conclusion of hostilities the personnel situation on the National Forests has grown very acute. The resumption of peace time activities upon the Forests threw a larger burden upon the organization before the men on military furlough had returned and before the personnel could be built up to meet the current requirements. At the same time, many men who had loyally remained with the service during the war felt that they no longer could justify to themselves the refusal of offers for outside employment at greatly increased compensation.

It was pointed out last year that the rate of pay of the National Forest force was entirely inadequate to attract and hold men of the training and experience needed to discharge the responsibilities involved. The forest officers are the guardians of the public property and the administrative managers who handle the great variety of business connected with the use of the properties. The safeguarding of the resources requires men of training in protective work that comes from long experience, and the same is true of the handling of timber sales, grazing, and other lines of business. Efficient service to the public necessitates competent forest officers. The standards of salaries paid today were set about nine years ago. These standards are not at all commensurate with the responsibilities involved, quite aside from any question of present-day cost of living.

During the past season the Forest Service has had the most serious fire situation in its history, due to the exceptionally severe and prolonged drought. In many cases the loss of experienced forest officers made it necessary to place men of relatively small training in charge of important districts. Fires grew large which would have been promptly extinguished if the men had had greater experience. The same effect appeared in the handling of various lines of business. The administration of grazing has suffered materially because of the difficulty of holding experienced men.

The salary of forest supervisors, exclusive of the bonus, now averages \$1,958, that of deputy forest supervisors \$1,524, and that of forest rangers \$1,154. Many supervisors have charge of a million acres of public property and of resources not uncommonly valued at 15 to 20 million dollars. Often a single ranger district comprises 150,000 acres and resources of very great value, for which the ranger is directly responsible.

The position of forest supervisor and also that of forest ranger are in a very real sense technical, and the standards of remuneration should be such as to enable the Government to secure and hold trained men of the highest type and integrity. The effectiveness of the entire administrative system depends on the quality of the Forest force.

In the last few months the difficulties of maintaining an efficient organization have become increasingly aggravated. Impairment of the organization and reduction in efficiency of service are inevitable if some action can not be taken to check the flow of the experienced men who can not be retained on account of the low pay. If the present condition continues it will be necessary to build up practically a new organization, through a term of years; and in the meantime the public will suffer because of the lower efficiency of inexperienced men. In fact, through inefficient service the entire National Forest enterprise may be set back. The situation is one that should receive careful consideration in the interest of the public. Already protest has begun to be made by users against the effect of the changes of personnel, while internal evidences of poorer efficiency and increasing strain imposed on the organization are becoming manifest.

THE NATIONAL FORESTS.

RECEIPTS AND OPERATING EXPENSES.

The receipts from the National Forests in the fiscal year 1919 were greater by \$783,484.79 than in the previous year. This is the largest increase ever made in a single year. The receipts totaled \$4,358,414.86.

To this total the grazing business contributed \$2,609,169.85, the timber business \$1,540,099.96, special uses (i. e., the occupancy of lands for miscellaneous purposes), \$136,822.99, and use for water-power development, \$72,322.06. The receipts from grazing exceeded those of 1918 by \$883,347.91, while the receipts from timber declined \$93,549.46. Special uses showed a gain of \$15,616.05, and water power a falling off of \$21,654.29.

The falling off in the receipts from timber was not due to any material reduction in the current timber sale business but is explained chiefly by the fact that in 1918 settlement was secured under a court judgment of a claim against one of the transcontinental railroad companies amounting, with interest, to \$89,264.

The increase in the receipts from grazing was due to the fact that last year the final step was taken in carrying through the advance in the grazing fees, proposed in 1916 and inaugurated in 1917.

With the stockmen paying more than two and one-half million dollars annually into the public treasury for use of the National Forest ranges, there is strong reason for their urging that the Government expenditures aimed at making the range more useful should be increased. Unquestionably the value of the range, to the live-stock producers and to the country, can be developed to a higher point by constructing more improvements and pushing further the investigations which make possible the most efficient and complete utilization of the forage crop and the most highly perfected methods of live-stock management. Since the Government receives a return on what may be called development expenditures, in the form of additional grazing fees, increased expenditures for this purpose would seem wise as well as reasonable.

That the receipts from grazing now exceed those from timber by more than a million dollars and form 59 per cent of the total receipts from all sources is due to the fact that practically the entire forage crop can under present conditions be utilized, while the annual timber cut is but an insignificant fraction of the sustained yield obtainable from the Forests, or of the total cut of the country. There is very

little range which is not accessible to live-stock, but the bulk of the timber is still out of reach of the lumbermen.

The receipts of 1919 were 175 per cent of those of 1915, while the cost of operating the Forests has remained practically stationary during these four years. The appropriation act for the current year made increases in the items for a number of the individual Forests, aggregating \$266,074. Most of these increases were to strengthen the protective system on the Forests where the danger of costly and destructive fires is greatest because of the inaccessibility of the country. These new funds did not become available until after July 25, when the fire season was reaching its height, which precluded the carrying out of the plans contemplated when the increases were asked for. Before the end of June the worst fire season ever faced in the Northwest had begun. When it ended the expenditures for fire fighting had so far exceeded the appropriation for that purpose that it became necessary to ask a deficiency appropriation from Congress of \$2,950,000. Again, as in last year's report, it must be pointed out that greater outlays for fire prevention, early detection, and swift concentration of fire-fighting forces would be much more economical.

THE NATIONAL FOREST PROPERTIES.

The net area of the National Forests at the close of the fiscal year 1919 was 153,933,700 acres, as against 155,374,602 acres June 30, 1918. The corresponding gross areas were 174,261,393 acres and 175,951,266 acres. The gross area includes all lands within National Forest boundaries; the net area excludes alienated lands.

These figures indicate a decrease of 1,440,902 acres in net area and a decrease of 1,689,873 acres in gross area. Eliminations made either by presidential orders or proclamations or by special acts of Congress totaled 1,658,989 acres, in 25 National Forests. The act of February 26, 1919, creating the Grand Canyon National Park, eliminated from the Kaibab and Tusayan National Forests and transferred to the Grand Canyon National Park 606,720 acres. State selections authorized under a proclamation of June 4, 1912, were approved in the St. Joe National Forest, in Idaho, aggregating 21,262 acres. Eliminations by Executive orders or presidential proclamations, as a result of the land classification that is now nearing completion, reduced the National Forest areas 1,031,007 acres. Furthermore, a considerable acreage passed into private ownership under the usual operations of the mining laws and the Forest homestead act.

These reductions in area were in a small degree offset by three small public-land additions. Presidential proclamations increased the Dixie National Forest in Utah 8,328 acres and the Humboldt Forest in Nevada 28,020 acres. By the act of March 3, 1919, 2,886 acres were added to the Minam Forest in Oregon.

Increase of the National Forests in the East through purchases continued at a conservative rate. The total net area of public land in the National Forests established from purchase areas now aggregates 1,347,666 acres. Of this amount 1,333,405.03 acres have been purchased, the remainder being unoccupied and unentered public lands in the Alabama National Forest. At the close of the fiscal year there remained a total of 396,493 acres approved for purchase by the National Forest Reservation Commission and under process of

acquisition, and the plans for ultimate acquisition embraced additional areas aggregating 4,422,167 acres. The purchase activities were largely confined to areas previously approved for purchase and to the consummation of negotiations already pending. The National Forest Reservation Commission desires, so far as practicable, to round out and complete the present purchase areas for practical administrative units before initiating purchase activities in other regions.

At the close of the fiscal year there were pending in the Interior Department proclamations providing for additions in the Western States totaling 283,780.54 acres. Of this 75,050 acres represents additions in the State of Wyoming authorized by special acts of Congress. The prevailing sentiment in the public-land States is now generally favorable to the extension of the Forests. This is indicated by the fact that at the present time there is pending in Congress legislation providing for 10 different additions to National Forests in the public-land States in which such additions can only be made with the consent of Congress. These proposed additions aggregate approximately 1,700,000 acres. The most important of the projects now before Congress is one for adding to the Idaho and Payette National Forests the region commonly known as the Thunder Mountain country, of approximately 1,120,000 acres. This proposed addition was discussed in last year's report. It has been strongly urged by successive sessions of the Idaho State Legislature, and is very desirable in order to give this area the protection and regulation it has so long and so urgently needed.

PROTECTION.

Mention has already been made of the emergency conditions which arose during the fire season of 1919 in the Northwest. The National Forests of western Montana and northern Idaho are heavily timbered, and most of the country which they cover is exceedingly mountainous, rugged, and undeveloped. Because of its wild character, its remoteness from centers of population and bases of supply, its lack of means of communication, its large stand of valuable timber and importance for watershed protection, and because of the climatic conditions, it presents the problem of protection in its most extreme form. Nowhere else, experience has proved, is the control of fires so difficult or so expensive.

The region is subject to severe droughts, in which almost no rain may fall for months; when such drought seasons occur the forests become almost like tinder; and frequent electric storms supply the sparks. Lightning fires generally start in the high mountains, where they are most difficult to reach and fight. Their control necessitates special provision, first, for discovering and getting to them quickly before they have gathered headway; and, secondly, for throwing against them and maintaining in the field large forces of fire fighters in case their immediate suppression becomes impossible.

The experience of the past season simply emphasizes the conclusion set forth in my report of a year ago. The protective system must be strengthened along lines which will permit of quicker work. The choice is between, on the one hand, provision for a moderately expanded regular protective organization or, on the other hand, unnecessarily large danger of terrific fires and huge emergency expendi-

tures. Last summer these emergency expenditures for fire fighting in the western Montana and northern Idaho Forests came to more than ten times the regular protective funds provided for the same Forests. While the danger of great fires can no more be entirely eliminated on the National Forests than it can in our large cities, it can and should be minimized.

Control of last summer's fires was made especially difficult by various circumstances. The delay in the enactment of the Agricultural appropriation bill embarrassed the early building up of the protective organization. Labor was at times difficult to secure to the extent needed, and was generally less efficient than usual; while it was always hard to secure men experienced in fire fighting for foremen. Very serious, however, was the further fact that the Forest Service has been losing its trained men very rapidly, owing to its inability to hold men at the present rates of compensation prescribed by law; and in consequence in many cases the forest officers were comparatively new men or men who had been recently transferred from some other district and had not yet become thoroughly familiar with the local country. Undoubtedly this was responsible for failure in a number of instances to get fires extinguished more promptly and economically.

Through a succession of unusually dry years the Forest Service has been able to prevent a catastrophe. It has held down the loss of merchantable timber to an amount which, under the circumstances, is reasonably small. It has prevented injury and destruction to property worth several hundred million dollars. On the other hand, a large expenditure has been required to fight fires, and in the aggregate a large area of old burns has been burned over, with resulting destruction of a great deal of young growth. The reasons for the failure to secure better results may be summed up as follows:

(1) The Forests have not yet been sufficiently opened up with roads and trails. It is still necessary in many cases to build trails through the woods to the fires. This may require several days, during which a fire may have become a great conflagration.

(2) The regular protective force is insufficient.

(3) The Forest Service is almost wholly unequipped with motor transport. Aside from the fact that the cost of hiring trucks to transport men and supplies for fire fighting is very large, the difficulty of obtaining such transportation sometimes results in failure to reach a fire before it is too late. Adequate equipment with motor trucks would save a great many thousand dollars each year.

(4) Successful fire protection is absolutely dependent on a permanent force of trained men. Without that, fires which should be put out promptly with little loss or cost spread widely and require many thousands of dollars to prevent disaster, let alone extinguish them.

(5) Public sentiment in many places has not yet roused to the need of care in the forest and public cooperation. There are still too many railroad fires, too much carelessness in the woods, particularly from smoking, and too many fires from clearing land.

The answer to the forest fire problem is therefore more roads and trails, sufficient salaries for our forest officers to enable the building up and holding of a well-trained force, greater leeway in furnishing motor equipment for fighting fires, which could also be used in road improvements, and a more vigorous campaign to educate the public to better cooperation in fire protection.

There were relatively few large fires during the fiscal year on the National Forests elsewhere than in the northern Rocky Mountains and Pacific Coast States, although unfavorable conditions were widespread. In the last six months of the calendar year 1918, after an early summer fire season of unusual danger in all parts of the West, except in Colorado, Wyoming, and South Dakota, where light rains fell with sufficient frequency to mitigate the drought, the situation improved materially as the season advanced. The fall rains generally set in early; and in the Southwest, where the fire danger occurs in two distinct seasons, one in the spring and early summer and one in the fall, the fall fire season was of short duration, with good showers at frequent intervals. In southern California conditions were threatening until late in the fall, but throughout the State the fires of the latter part of the calendar year 1918, were well controlled. Especially notable was the reduction in the number of man-caused fires in California which followed a vigorous campaign of public education waged by the Forest Service in cooperation with State and other public agencies. In Minnesota no large fires burned on the National Forests, in conspicuous contrast with what happened in other parts of the State. In the southern Appalachian Forests the climatic conditions during the fall were less favorable than normally, but only one large fire occurred; this was on the Shenandoah, in October.

The following table gives certain statistics regarding the 1918 fires. The total number, 5,573, shows a reduction of 2,241 from the number which occurred in the previous calendar year. The area of National Forest lands burned over was 694,651 acres, as against 962,543 in 1917; the estimated damage on these lands was \$688,332, as against \$1,358,627; and the total cost of fire fighting was \$714,009.63, as against \$1,121,451.

Fires on National Forests, calendar year 1918.

Extent and causes of fires.	Number of fires.	Percentage of total.	Extent and causes of fires.	Number of fires	Percentage of total.
Area burned over:			Causes of fires:		
Under 0.25 acre.....	2,475	44.41	Railroads.....	618	11.09
Between 0.25 acre and 10 acres.....	1,572	28.21	Lightning.....	2,457	44.09
10 acres and over, damage under \$100.....	1,146	20.56	Incendary.....	257	4.61
10 acres and over, damage \$100 to \$1,000.....	270	4.85	Brush burning.....	361	6.48
10 acres and over, damage over \$1,000.....	110	1.97	Campers.....	943	16.92
Total.....	5,573	100.00	Lumbering.....	104	1.86
			Unknown.....	658	11.81
			Miscellaneous.....	175	3.14
			Total.....	5,573	100.00

Of the 110 fires listed above as having burned over an area of 10 acres and more with damage in excess of \$1,000, 35 were in Idaho, 30 in Oregon, 14 in Washington, and 12 in California. In total number of fires of all classes California came first, with 1,148, followed by Idaho with 832, Oregon with 775, Montana with 573, and Washington with 563. Seventy per cent of all the fires occurred in these five States.

Since the fire season of 1919 is not yet closed, final statistics regarding this year's fires can not of course be given. Preliminary estimates indicate an area burned over up to September 30 of approximately 1,500,000 acres, while the fire fighting expenditures from July 1 to September 30 were close to \$3,000,000.

MANAGEMENT.

TIMBER.

There was a decrease of 3 per cent in the cut of National Forest timber under sales, and of 0.5 per cent in the receipts from sales. In a period when the lumber cut of the United States as a whole dropped off 11 per cent, this sustained use of National Forest timber indicates the stable source of supply which has been established in the National Forests for the local lumber industry and for the general timber requirements of the country. New sales of timber decreased 45 per cent. This decrease is attributable to the war production conditions existing during the first part of the year and to the high cost of steel rails, machinery, and other materials, which has discouraged the development of new lumbering enterprises in the National Forests.

Since April, 1919, the lumber market has been characterized by advances in prices exceeding in rapidity anything previously known in the history of the industry. This condition appears to be due to the sudden and wide-spread resumption of building activity and to the shortage of existing lumber stocks. The production of lumber is responding but slowly to this demand on account of the shortage of labor and the high cost of supplies. The advance in lumber has, however, been reflected during the last three months in a sharpened demand for National Forest stumpage, which bids fair to increase materially the rate of cutting. Such increases will be progressive and somewhat slow, because a certain length of time is required for the appraisal and advertisement of large tracts and time is needed also for new installations under present conditions.

One of the more important developments in forest management which must be pushed with vigor is to determine within closer limits than has yet been possible the quantities of timber which may be cut from forest units on a basis of permanent production. The demand for National Forest timber in some localities has about reached the growing capacity of the areas forming the logical source of supply. It is of the utmost importance that the industrial developments supported by National Forest stumpage be permanent and that no pressure for the immediate use of timber be permitted to exhaust such National Forest areas within a few years, leaving a wake of sawdust piles and deserted lumber camps. The general principles upon which this development of National Forest management has been undertaken are: (1) To define areas, on the basis of topographic features or of industrial and economic factors, from which a steady yield of timber should be obtained; and (2) to determine the safe limit of yearly sales from each area in order that the yield may be continuous. Securing permanent and desirable conditions for labor in forest industries is an important phase of this development.

A second important extension in the effective use of National Forest timber is to obtain exact data upon their resources for making

paper, both as to suitable woods and as to hydraulic power; and to make these resources available to paper manufacturers under practicable terms in view of the transportation and other conditions attending the extension of their industry into the Western States. The National Forests contain upward of 200 billion board feet of timber suitable for the manufacture of news print. Sales of pulpwood are now being made at a number of points as part supply for established paper plants. Several large tracts of timber of paper-making species have been appraised and advertised for sale or offered to the paper trade. Transportation conditions, labor problems, and the large investments required for the installation of paper plants have held back the development of such enterprises on the National Forests, notwithstanding the favorable timber and water-power conditions which are to be found at many points. This development, however, is bound to come, in view of the general paper situation in the United States; and the Forest Service is preparing for it.

Owing to the handicaps imposed by the reduction of field personnel in consequence of the war, timber surveys have been materially curtailed since 1916. With the prospect of increased activity in sales to lumber manufacturers and the need to be ready for the demand for timber likely to arise from paper manufacturers, it is important to expand again the timber-survey work. This work is fundamental to plans for wise management. During the year 448,547 acres were cruised and mapped by intensive methods and are now ready for timber sales, while 37,551 acres were covered by extensive reconnaissance.

The Agricultural appropriation act for the fiscal year contained a special provision for granting National Forest timber required for war purposes to any department, board, or committee of the Federal Government. Owing to the late passage of this measure, but one permit was granted under it to the War Department. This covered 6,000,000 feet, board measure, of which approximately 3,750,000 board feet were cut. Permits aggregating 5,758,000 board feet were issued to the Alaskan Engineering Commission under the act of March 4, 1915. This commission has cut to date approximately 30,000,000 board feet, under permit from the National Forests in Alaska.

Details regarding the cut and sale of timber are embodied in the following tables:

Timber cut under sales, fiscal year ended June 30, 1919.

State.	Board feet.			Value.		
	Commercial sales.	Cost sales.	Total.	Commercial sales.	Cost sales.	Total.
Alaska.....	44,764,000	.....	44,764,000	\$99,893	.....	\$99,893
Arizona.....	41,174,000	333,000	41,507,000	95,135	\$264	95,399
Arkansas.....	21,772,000	242,000	22,014,000	62,224	195	62,419
California.....	84,703,000	1,210,000	85,913,000	189,785	666	190,451
Colorado.....	46,762,000	1,320,000	48,082,000	87,827	995	88,822
Florida.....	578,000	.....	578,000	1,234	.....	1,234
Georgia.....	1,725,000	.....	1,725,000	4,744	.....	4,744
Idaho.....	63,550,000	4,252,000	67,802,000	160,011	3,170	163,181
Michigan.....	236,000	.....	236,000	344	.....	344
Minnesota.....	8,468,000	.....	8,468,000	33,107	.....	33,107
Montana.....	66,031,000	5,971,000	72,002,000	144,768	4,958	149,726
Nevada.....	1,504,000	61,000	1,565,000	2,110	45	2,155
New Hampshire.....	4,116,000	.....	4,116,000	21,268	.....	21,268
New Mexico.....	40,633,000	419,000	41,052,000	91,139	367	91,506
North Carolina.....	4,876,000	.....	4,876,000	15,506	.....	15,506
Oregon.....	114,911,000	2,669,000	117,580,000	233,781	1,576	235,357
South Dakota.....	14,663,000	757,000	15,420,000	33,323	697	34,020
Tennessee.....	1,711,000	156,000	1,867,000	3,874	117	3,991
Utah.....	13,759,000	915,000	14,674,000	31,044	699	31,743
Virginia.....	6,709,000	16,000	6,725,000	17,768	15	17,783
Washington.....	78,073,000	576,000	78,649,000	119,013	308	119,321
West Virginia.....	2,000	.....	2,000	10	.....	10
Wyoming.....	25,436,000	700,000	26,136,000	57,573	598	58,171
Total, 1919.....	686,156,000	19,597,000	705,753,000	1,505,481	14,670	1,520,151
Total, 1918.....	707,182,000	21,641,000	728,823,000	1,511,825	16,300	1,528,125

Timber sold fiscal year ended June 30, 1919.

State.	Board feet.			Value.		
	Commercial sales.	Cost sales.	Total.	Commercial sales.	Cost sales.	Total.
Alabama.....	.....	15,000	15,000	.....	\$82	\$82
Alaska.....	47,650,000	.....	47,650,000	\$81,216	.....	81,216
Arizona.....	69,967,000	494,000	70,461,000	139,249	396	139,645
Arkansas.....	10,627,000	286,000	10,913,000	47,096	217	47,313
California.....	239,919,000	1,981,000	241,900,000	565,006	1,087	566,093
Colorado.....	54,536,000	1,501,000	56,037,000	123,158	1,130	124,288
Florida.....	1,911,000	.....	1,911,000	4,825	.....	4,825
Georgia.....	1,977,000	.....	1,977,000	4,927	.....	4,927
Idaho.....	79,898,000	6,329,000	86,227,000	151,832	4,727	156,559
Michigan.....	268,000	3,000	271,000	292	.....	294
Minnesota.....	4,043,000	.....	4,043,000	19,086	.....	19,086
Montana.....	28,462,000	8,256,000	36,718,000	60,642	6,662	67,304
Nevada.....	854,000	72,000	926,000	1,060	54	1,114
New Hampshire.....	2,580,000	.....	2,580,000	11,376	.....	11,376
New Mexico.....	15,299,000	541,000	15,840,000	42,826	399	43,225
North Carolina.....	36,549,000	.....	36,549,000	112,350	.....	112,350
Oregon.....	92,192,000	2,866,000	95,058,000	237,355	1,636	238,991
South Dakota.....	24,843,000	811,000	25,654,000	68,905	698	69,603
Tennessee.....	4,776,000	200,000	4,976,000	15,404	150	15,554
Utah.....	11,983,000	1,399,000	13,382,000	27,998	1,092	29,090
Virginia.....	4,509,000	16,000	4,525,000	9,886	15	9,901
Washington.....	32,312,000	637,000	32,949,000	71,728	334	72,062
West Virginia.....	2,000	.....	2,000	10	.....	10
Wyoming.....	8,052,000	860,000	8,912,000	19,493	770	20,263
Total, 1919.....	773,209,000	26,267,000	799,476,000	1,815,420	19,451	1,834,871
Total, 1918.....	1,425,258,000	28,041,000	1,453,299,000	3,295,516	21,341	3,316,857

Number of timber sales, classified according to amount of sale, fiscal year ended June 30, 1919.

State.	\$100 or under.			\$101- \$500	\$501- \$1,000	\$1,001- \$5,000	Over \$5,000.	Total.
	Com- mercial.	Cost.	Total.					
Alabama.....		8	8					8
Alaska.....	500		500	1	3	18		522
Arizona.....	696	169	865	4	1	6	1	877
Arkansas.....	38	76	114	8	5	3	4	134
California.....	373	353	726	14	9	12	9	770
Colorado.....	529	232	761	12	7	15	7	802
Florida.....	24		24			1	1	25
Georgia.....	57		57			1	1	58
Idaho.....	599	1,364	1,963	12	6	12	9	2,002
Michigan.....	8	1	9					9
Minnesota.....	6		6			1	1	8
Montana.....	674	1,894	2,568	21	7	8	2	2,606
Nevada.....	69	6	75					75
New Hampshire.....	120		120	2	1	3		126
New Mexico.....	694	251	945	7	4	6	1	963
North Carolina.....	109		109	5	5	5	1	125
Oregon.....	243	466	709	7	2	3	3	724
South Dakota.....	342	144	486	8	6	12	2	514
Tennessee.....	56	56	112	1		2	1	116
Utah.....	458	725	1,183	7	4	1	1	1,196
Virginia.....	266	8	274	2		2		278
Washington.....	213	128	341	6	1	3	3	354
West Virginia.....	1		1					1
Wyoming.....	152	140	292	3	3		1	299
Total, 1919.....	6,227	6,021	12,248	120	64	114	46	12,592
Total, 1918.....	6,670	5,907	12,577	160	89	147	64	13,037

¹ 1 cost sale.

REFORESTATION OF DENUED LANDS.

Notwithstanding the drought during the last two seasons, a good percentage of success has been secured in most of the forest plantations on denuded lands in the National Forests. This is probably due to the experience which has been gained in the production of nursery stock and in the more effective methods of planting it in the field. A total of 6,911 acres was planted and seeded during the fiscal year. The largest planting operations are being conducted in the Northwest. Small plantations in the Lake States have been very successful, and the work will be largely extended in this region within the next five years. Some of the older plantations conducted by the Forest Service, particularly near Halsey, Nebr., are now assuming forest proportions and establishing veritable forest conditions in the midst of vast areas of treeless land.

The details of planting and sowing operations are given in the following table.

Planting and sowing on National Forests, by States, 1919.

State.	Area planted.	Area sowed.	Total.	State.	Area planted.	Area sowed.	Total.
	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>		<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Oregon.....	1,449.00		1,449.00	California.....	179.00		179.00
Idaho.....	1,344.00	150.00	1,494.00	New Mexico.....	31.00		31.00
Montana.....	1,000.00		1,000.00	Arizona.....	3.00		3.00
Colorado.....	612.32		612.32	Nevada.....	1.20		1.20
Washington.....	533.00		533.00	South Dakota.....	1.00		1.00
Nebraska.....	513.63		513.63	Florida.....	.33		.33
Minnesota.....	441.00		441.00				
Michigan.....	399.00		399.00	Total.....	6,761.38	150.00	6,911.38
Utah.....	253.90		253.90				

RANGE.

Very exceptional range conditions characterized the seasons of 1918 and 1919. The closing of the 1918 season marked the termination of a prolonged drought throughout the Southwest, particularly in New Mexico, Arizona, and Texas. A very severe winter with a heavy snowfall followed, which caused heavy losses of stock of all classes. The 1919 season throughout the Southwest was unusually favorable for forage growth. Throughout Montana, Idaho, Utah, Wyoming, northern Colorado, the western half of Nebraska, and North and South Dakota, however, one of the most severe droughts in the memory of the oldest stockmen has prevailed. This drought probably reached its greatest intensity in Montana, northern Wyoming, eastern Utah, and Idaho. For three years the precipitation in this region during the growing season has been very light, but the 1919 conditions were the worst. The snowfall at the beginning of the year in the entire drought region was unusually small, and while a few heavy snows fell in the latter part of the winter, the snow did not pack and disappeared rapidly when warm weather set in. Temperatures during April and early May were much above normal, causing the snow to melt and run off sooner than usual. This caused a shortage of water for irrigating and stock watering purposes.

Forage growth of all kinds started early, with indications of a good season. Heavy freezes, however, during the last few days of May destroyed all of this new vegetation, upon which the sheepmen were dependent for feed for their flocks during the lambing period. These conditions also affected the cattlemen to some extent, as their stock did not immediately begin to increase in flesh. A long period of low precipitation immediately followed in the States above named, which greatly reduced forage growth.

The stream flow was far below anything previously recorded, and this had a direct influence upon the raising of farm crops, particularly hay, which has been reported as from 20 to 50 per cent below normal.

The production of forage on the unreserved public lands was very restricted, and the stockmen using these areas were forced to seek other range. The National Forest ranges, being at higher elevations, were not so greatly affected, and stockmen who held Forest permits were considered very fortunate. During the early part of July heavy rains occurred in northern Arizona, southern Utah, and parts of Nevada, which relieved range conditions materially throughout this region and reduced the drought area considerably. During the latter part of July rains occurred in northern Utah and southern Idaho. While they came too late to cause any appreciable increase in the hay crop, an immediate improvement in the summer, fall, and winter range was noticed, thus still further reducing the drought area.

The range situation looked so critical early in July that the Department of Agriculture considered it necessary to assist the stockmen in the drought regions. A committee organized for this purpose immediately undertook a canvass of the drought-stricken region to determine the numbers of stock for which other pasturage or winter feed would have to be provided in order to avoid placing this stock upon the market, and also sought to locate in other States places where feed or pastures could be secured for wintering stock shipped in from the drought-stricken region. The Forest Service cooperated with the

committee in making the canvass, by gathering data regarding the stock on the National Forest and adjacent ranges. It appeared that very heavy shipments would have to be made from the intermountain region. The situation in Montana and Wyoming was even more critical, for in many places in these States the estimates indicated that at least 75 per cent of the stock would have to be shipped to market or feeding points.

The relief committee, with the cooperation of many county agencies, agricultural representatives, and other Department representatives, is assisting stockmen to avoid the necessity of placing their drought-stricken stock on the market at a sacrifice by directing them to winter feed. In addition, it has been developed that large quantities of hay are available in the Middle Western States at prices sufficiently low to permit of its shipment into the drought regions for winter feeding. This fact with the localized rains that occurred over a large portion of the region during the latter portion of the season will greatly reduce the number of stock to be disposed of on account of lack of feed. The conditions in eastern Idaho, Wyoming, and Montana have not greatly improved, and it will be necessary for the stockmen in those States to make heavy shipments.

Live stock and wool prices fell off materially during the year. In the fall of 1918 prices were unusually good. An unusually mild winter, except in the Southwest, brought the stock through in excellent condition, without the necessity of heavy expenditures for hay or concentrated feed. The first evidence of declining prices was observed in the wool sales last spring. In addition the stockmen had serious difficulties in securing competent help. Old employees familiar with range conditions and Forest regulations readily found more remunerative and easier positions in other lines of work.

The importance of the National Forest ranges to the stockmen was strongly emphasized by the events of the year. Never before was the demand for range on the Forests so great. This was particularly true in the drought-stricken regions, where stockmen, using the unreserved public domain or private pastures, eagerly sought Forest permits in order to save their stock. The value of the system of range regulation in use has been so thoroughly demonstrated that at the public lands convention held in Salt Lake City on August 21—a gathering of representative stockmen from all of the Western States—the convention went on record in favor of placing the remaining unreserved public lands under Federal control and having them managed under a plan similar to that in effect on the National Forests.

A plan for granting 5-year permits was put into effect on a large number of the Forests. It is too early to determine the results.

Larkspur eradication upon the scale desired proved impossible, partly for lack of men to supervise the work, partly because the scarcity and high cost of labor prevented the stockmen from cooperating extensively. However, larkspur was eradicated from 1,657 acres during the year, making a total of 3,580 acres grubbed since the work began, at a cost of \$5.50 per acre. The stockmen contributed about one-half the expense. A resultant saving in cattle of \$34,000 annually is estimated, on the basis of the average previous recent death loss and a valuation of \$50 per animal.

It was planned to carry on the eradication work for the season of 1919 on all projects not completed, and to undertake grubbing on new

areas where cooperation could be secured and funds were available. The exact acreage infested is not definitely known, but from the number of cattle reported as dying on infested ranges it is evident that a large saving is feasible. With the present great demand for Forest range and high prices for cattle the need for continuing the eradication work can not be overemphasized.

The following table shows the number of permits issued and number of stock grazed upon the Forest ranges during the fiscal year ended June 30, 1919:

Grazing permits issued and number of stock grazed.

State.	Cattle, horses, and swine.				Sheep and goats.		
	Permits issued.	Number of stock grazed.			Permits issued.	Number of stock grazed.	
		Cattle.	Horses.	Swine.		Sheep.	Goats.
Alabama.....	2	59					
Arizona.....	1,570	360,011	6,509	637	160	364,853	6,604
Arkansas.....	452	4,591	80	494	15	49	230
California.....	3,021	208,683	7,019	3,324	551	606,526	13,286
Colorado.....	4,455	380,460	9,503		872	1,044,208	1,322
Florida.....	23	787		6			
Georgia.....	48	440	14	15	3	23	
Idaho.....	4,213	190,608	13,794		1,093	1,758,877	
Michigan.....					2	91	
Montana.....	2,865	170,674	16,524		521	835,224	134
Nebraska.....	54	12,757	713				
Nevada.....	502	77,432	4,320		109	390,753	
New Hampshire.....	15	158	12				
New Mexico.....	2,020	174,979	5,309	467	576	440,302	39,051
North Carolina.....	186	1,157	52	56	5	82	
Oklahoma.....	57	3,304	294				
Oregon.....	2,478	162,004	10,066	88	537	753,418	52
South Dakota.....	786	38,185	3,184		8	12,200	
Tennessee.....	47	431			5	75	
Utah.....	7,249	172,246	9,914	67	1,641	811,510	110
Virginia.....	273	2,614	15		1	6	
Washington.....	1,031	30,743	2,318		196	236,307	
Wyoming.....	1,181	143,204	3,611		329	680,670	
Total, 1919.....	32,528	2,135,527	93,251	5,154	6,624	7,935,174	60,789
Total, 1918.....	32,600	2,137,854	102,156	3,371	6,513	8,454,240	57,968

There was a reduction of 72 cattle and horse permittees and an increase of 111 sheep and goat permittees, making a net increase for both classes of 39 as compared with the previous year. Fewer cattle, horses, and sheep were grazed, but the number of swine and goats slightly increased. The horses grazed on the National Forests are very largely of a small and inferior type which do not return a profit to the owner; consequently there has been a marked tendency on the part of these owners to dispose of their horses and substitute more valuable kinds of stock.

It will be observed that the decrease in the number of cattle was insignificant—only 2,327; but that the number of sheep was decreased by over 500,000. During the grazing seasons of 1917 and 1918 the number of cattle on the National Forests was increased over 379,000 head and the number of sheep over 611,000 head, as a war emergency measure. Since the closing of the war it has been necessary to reduce the number of stock on many of the ranges to prevent serious damage to the ranges. Investigations showed that forage could be provided for practically the full number of cattle, but that a reduc-

tion in the number of sheep to practically the pre-war number was imperative. The bringing into use of more range for cattle through the eradication of poisonous plants, securing a more uniform utilization of the forage on the cattle range through better distribution, and the adoption of the common use of range by cattle and sheep whereby a limited number of cattle utilize forage not palatable for sheep are the reasons why there has been practically no reduction in the number of cattle.

LIVE-STOCK ASSOCIATIONS.

Regulated management of the National Forest ranges during the past 14 years has had a marked influence on the formation of live-stock associations and the development of this field of activities. The old system under which each permittee gave individual attention to his stock while on the range is being widely replaced by a pooling of interests along certain lines, accomplished by forming live-stock associations with executive committees to handle many of the details of stock management. Many of the executive committees employ herders for the stock while on the range, buy and distribute salt, in some cases buy bulls, and take charge of other management and improvement matters which promote the best interests of the permittees and the highest use of the range. The method employed is the adoption of special rules, passed by the association and approved by the Forest Service. Compliance with these rules is then required of all users of the National Forest range involved. Practically all of the more progressive associations have adopted such special rules as meet the needs of their localities. Membership in the association is open to all live-stock owners using the range in question, and a majority of all users must belong to the association in order to secure its recognition by the Forest Service.

The advantages of cooperation are shown by the number of live-stock associations recognized by the Forest Service. In 1917, 359 stock associations were cooperating with the Service. Last year there were 544, an increase of over 51 per cent. So firm are the owners of live stock that graze upon the National Forest ranges in their belief in the value of organization that of the 4,246 permittees in the States of Oregon and Washington over 3,000 are members of live-stock associations.

In many cases advisory boards have recommended reductions in the number of stock upon a given range; they have also suggested changes in grazing seasons, with a view to securing the greatest benefits to the users and an improvement in the range. In practically all cases associations have interested themselves in constructing range improvements such as drift fences, in water development, in the eradication of poisonous plants, and similar matters. The expenses for the improvements are secured through assessments. The value of organized cooperation is most evident on range allotments where conditions of use are very intensive and the permitted stock belongs to a large number of small owners.

WATER POWER.

Not much water power development has taken place since the United States entered the war. Increased war demands for electric power could not be deferred for the time necessary to construct

water-power plants but had to be met in greater part by the construction of new steam plants and by the interconnection of existing plants. At present financial and industrial uncertainties and the unsatisfactory character of Federal laws are resulting in further postponements of water-power utilization. Any considerable utilization of our undeveloped water powers must await both the enactment of legislation and the stabilization of the general economic situation.

The receipts from water-power permits and easements were \$72,322.06, as compared with \$93,976.35 for the fiscal year 1918. Ten applications for preliminary rental permits were received, 14 for final rental permits or easements (of which 9 were for transmission lines only), and 11 for free permits or easements (of which 3 were for transmission lines only). Data concerning projects under permit at the close of the year are given in the following tabulation:

Water-power sites and transmission line rights of way under permit and easement, fiscal year 1919.

Class of permits or easements.	Transmission lines only.			Power projects ¹ (reservoirs, conduits, power houses).		Total number permits or easements.
	Number of permits or easements.	Length in miles.		Number of permits or easements.	Estimated average output (in horsepower) at minimum discharge.	
		Within Forest boundaries.	On National Forest land.			
Permits or easements in force at close of fiscal year:						
Rental permits or easements—						
Preliminary.....				13	180,633	13
Final.....	148	1,063.78	789.01	91	767,751	239
Free permits or easements.....	20	146.70	111.09	92	8,580	112
Total.....	168	1,210.48	900.10	196	956,964	364
Construction completed at close of fiscal year:						
Rental permits or easements.....	147	1,061.00	786.95	76	311,293	223
Free permits or easements.....	20	146.70	111.09	81	7,734	101
Total.....	167	1,207.70	898.04	157	319,027	324
Construction incomplete at close of fiscal year:						
Rental permits or easements.....	1	2.78	2.06	8	223,037	9
Free permits or easements.....				8	814	8
Total.....	1	2.78	2.06	16	223,851	17
Construction not stated at close of fiscal year:						
Rental permits or easements.....				20	414,054	20
Free permits or easements.....				3	32	3
Total.....				23	414,086	23

¹ With or without transmission lines.

RECREATION AND GAME.

Plans for the management of the National Forests must aim to provide for an orderly development of all their resources, for the use and benefit of the public. Such plans would be incomplete if they failed to take into account the wild life and the recreation resources.

Use of the National Forests for recreation was greater than ever before. There is not a single Forest, and there is scarcely a ranger

district, which does not have some features of recreation interest. Sometimes it is the mountain scenery, sometimes the beauty of forests, lakes, and streams, sometimes the opportunities for sport in the form of fishing, hunting, or mountain climbing, and sometimes it is still other kinds of attractions which lead yearly increasing number of visitors to the Forests for recreation and health.

Because of this expanding use adequate administration of the recreation resource has become of marked importance. The western National Forests are, by virtue of their location and character, the natural public playgrounds for most of the country west of the Mississippi, and they also draw many thousands of visitors from the East. They must be handled with full recognition of their recreation values, present and future. This requires careful and forward-looking plans providing both for the protection and the development of this important resource.

Protection of the recreation resource involves measures that will safeguard for the use and enjoyment of the public the natural attractions which appeal to visitors and cause them to seek the Forests and also measures that will reserve for their use adequate supplies of wood and forage and afford pure water. Development of the resource is a still larger matter. It involves many things, but the most urgent primary need is provision of facilities for traversing the Forests and for living while in the Forests.

All these matters received attention. In cutting timber, operations are adjusted to protect scenic features, roads, camping places, and the like against loss of attractiveness. Forage is reserved for the horses of recreation parties. Water protection is looked after through sanitary regulations, the provision of hotel and other accommodations is encouraged, information of various kinds supplied, and in general the convenience and comfort of visitors promoted.

Of particular importance for the increase of use is the systematic and progressive development of roads and trails by which the Forests are being made more generally accessible. Every road and trail, whether it is built primarily for protection or for the development of some material resource, opens up new features of scenic interest. In a variety of other ways also development to meet the increased demand for recreation use is being undertaken. A number of recreation centers are being made ready for the public under plans carefully worked out by recreation engineers. Various such centers are already in use, such as the Red Fish Lake and Wood River recreation areas in the Sawtooth National Forest in Idaho, Eagle Creek on the Columbia River Scenic Highway near Portland, Oreg., Denny Creek on the Sunset Highway near Seattle, Huntington Lake in the Sierra National Forest, the Los Angeles Municipal Camp in the Angeles Forest, and the Laguna Mountains recreation area between San Diego and the Imperial Valley. At many other points the Forest Service is constructing shelter houses, improved camping places, etc.

It is becoming manifest, however, that an adequate policy of recreation involves still more. The services which can be rendered the local and general public, on the one hand, and the resources available for meeting these needs, on the other hand, need to be studied in the most comprehensive and thorough-going manner to the end that coordinated development of all these resources—whether found within

the National Forests, or in National Parks, or in properties belonging to States and municipalities—may be secured. For example, the full recreation value of the Oregon National Forest, which surrounds Mount Hood and borders on the Columbia River Valley, can be realized only through a development coordinated with what the City of Portland and the Counties of Multnomah, Hood River, and Clackamas have undertaken to do and have largely accomplished. Such a coordination has in this particular case been effected, with most happy results. Again, recreation development in the Yellowstone Park region can not be made to serve the public interests to best advantage if National Forest administration is uncorrelated with the administration of Park, and vice versa. In short the National Forests, which must be administered with a view to recreation use as one of their major functions, can not carry out that function in fullest measure except through cooperative relations with other agencies in the same field, resulting in joint effort under a truly national and common policy.

The wild life resource of the National Forests is in many ways closely related to recreation. It comprises mainly the game, the fish, and the fur-bearing animals, and the matter of most immediate importance is suitable provision in the administrative plans for the perpetuation of the existing herds of elk.

In spite of difficulties created by war and other conditions that made it necessary to carry on the ranges all the domestic live stock for which a place could safely be found, progress was made in working out better methods of elk conservation and in providing more ample feeding grounds for the herds in and around Yellowstone Park. In general, recognition of the fundamental problem involved has been secured to a greater degree than ever before, and an increased public support has been obtained in carrying out the protective and constructive work necessary to solve the problem. The Forest Service is formulating as fast as possible plans which will coordinate the various other uses of the National Forests with game conservation. This is especially important in connection with grazing use. In places it is necessary to restrict or entirely prohibit grazing in order to take care of the elk. The most important single situation of this kind is that near the Yellowstone Park.

For several years a study has been conducted by the Forest Service in cooperation with the Biological Survey of the habits of the Yellowstone elk, their requirements, and other matters, knowledge of which is necessary as a basis for a practical program. This program, which was completed during the past year, calls for certain legislative and administrative action. A beginning was made on the administrative phases by imposing added restrictions upon the use by domestic stock of portions of the National Forests adjoining the park. Some lands were wholly reserved and others restricted to limited use by cattle during certain months. A beginning was also made in the progressive exclusion of stock from areas where total exclusion could not be put into effect at once. The program for handling the Yellowstone elk was placed before the public with a view to full discussion and consideration of the proposals for State and national legislative action.

While it may require slight changes and revisions from time to time as conditions alter, it is believed that the underlying principles are essentially correct. The program was approved by the Benevo-

lent and Protective Order of Elks at its last annual meeting, as well as by the leading sportsmen of the country. The study of these herds must necessarily be continued until the working plan is fully established.

The study of the Sun River elk herd in the Lewis and Clark Forest was continued, and an examination of the area used by the Roosevelt elk in the Olympic Forest was made to determine the number of elk in this herd, the range used during the different seasons of the year, and the number and kind of animals that would have to be disposed of annually if it appears that the herd should be maintained at its present size but not permitted to grow larger, on account of lack of suitable feeding grounds to support a greater number without recurring seasons of starvation.

Marked progress was made during the year in bringing together the interests of the States and the Federal Government in game matters. In various instances it has been possible to make State and Federal authority mutually supplementary in accomplishing things difficult for the Government or State working alone.

ROADS, TRAILS, AND OTHER IMPROVEMENTS.

As was stated in last year's report, great care was exercised in the selection of projects to be constructed during the calendar year 1918, to eliminate all which would tend to interfere in any way with the prosecution of the war. Although the amount of work which had been planned was very small and was restricted to projects for which an immediate need existed or where the prosecution of the war would be aided rather than hindered, it developed that the program could not be carried out. Labor was hard to get and efficiency was materially less than in preceding years. The high price of labor and materials forced postponement or reduction of work. Restrictions placed on road materials, mainly cement and steel, delayed construction or made necessary changes in design to utilize products which were locally available. However, a large amount of investigative and survey work was carried on in anticipation of an increased construction program following the end of the war.

The following tabulation shows the number of miles of public roads constructed or improved prior to December 31, 1918, from the 10 per cent of National Forest receipts, the appropriations under section 8 of the Federal aid road act and cooperative funds.

Construction and improvement of roads and trails¹ from the 10 per cent, section 8, and cooperative funds, by States.

State.	Total mileage to Dec. 31, 1918.	Total mileage in calendar year 1918.		
		10 per cent.	Section 8.	Total.
Alaska.....	21.37	0.16		0.16
Arizona.....	130.20	2.50		2.50
Arkansas.....	22.25	1.91	4.50	6.41
California.....	320.94	58.50	3.50	62.00
Colorado.....	213.01	33.34	7.00	40.34
Florida.....	10.00			
Idaho.....	253.11	75.22	1.00	76.22
Kansas.....	3.40			
Michigan.....	22.20			
Minnesota.....	2.00			
Montana.....	209.49	12.14	4.10	16.24
Nebraska.....	4.60			
Nevada.....	137.55		1.20	1.20
New Mexico.....	77.58	3.00	2.98	5.98
Oklahoma.....	28.00			
Oregon.....	188.84	29.64	1.70	31.34
South Dakota.....	14.05			
Utah.....	171.85	14.00	14.50	28.50
Virginia.....	1.50	1.50		1.50
Washington.....	108.88	30.00	1.70	31.70
Wyoming.....	78.85	2.75		2.75
Total.....	22,019.67	264.66	42.18	306.84

¹ Does not include bridge or maintenance work.

² Road construction, 1,046.39 miles; road repairs, 842.76 miles; trail construction, 119.52 miles; trail repairs, 11 miles.

³ Road construction, 77.76 miles; road repairs, 183.90 miles; trail construction, 3 miles.

⁴ Entirely road construction.

Immediately upon the cessation of hostilities, plans were made for utilizing as far as practicable all funds available for road survey and construction. This was not only to make up as far as possible for the almost entire stoppage of work during the two years of the war, but, even more, to provide an opportunity for the employment of labor released from war activities and temporarily idle. It was expected that labor would be plentiful and more efficient than in 1918. Actually, however, it has been difficult to obtain a sufficient supply, the quality has not been of the best, and, as a rule, the wage rate has not decreased. The cost of materials has on the whole increased.

In preparing the plans for the calendar year 1919, it was found that as a result of the construction costs being increased almost 100 per cent, the amount of available money, even though almost four years' appropriations were available for use, would be sufficient for hardly more work than could be financed in 1917. The situation was greatly relieved on February 28, 1919, when the Post Office appropriation act was passed. Section 8 of this act appropriates \$3,000,000 for each of the fiscal years 1919, 1920, and 1921, for expenditures in cooperation with the proper officials of a State, Territory, insular possession, or county, in the survey, construction, and maintenance of roads and trails within or partly within National Forests, when necessary for the use and development of resources or desirable for the proper administration, protection, and improvement of any Forest. The appropriation is available until expended. Cooperation may be waived by the Secretary of Agriculture under certain conditions for a project located entirely within the Forest boundaries.

For work located in part outside the Forest boundaries, cooperation must be secured.

The provision in the new appropriation act relative to cooperation has made possible the use of money on projects essential to the proper administration, protection, and development of the National Forests for which cooperation could not be secured because the projects were of minor value from the State or county standpoint. That the money could be utilized on administrative and protective roads and trails is equally advantageous, since the normal appropriation for such purposes was insufficient even for the maintenance of roads and trails previously built from the improvement fund.

With the increased funds it was possible to plan for the survey of 1,724.85 miles and construction of 1,643.31 miles, estimated to cost \$11,900,360.59. It was expected that \$4,407,302.31 of this amount would be obtained from cooperators. Arrangements were also made for a more intensive administrative study of road needs than had been possible or advisable under the smaller appropriations.

To what extent the approved plans for the calendar year 1919 will be executed can not now be determined. Increases in the estimated or actual costs, failure to obtain cooperation, and the difficulty in securing reasonable bids from reliable contractors have acted toward a reduction in the amount of work. The indications are that a large mileage of survey and construction will be completed by the end of the field season and that uncompleted approved projects will largely be under contract for completion during the winter or the construction season of 1920.

The following tabulation shows the projects approved and the liabilities involved during the fiscal year and prior to that time.

Summary of road and bridge projects undertaken to end of fiscal year 1919.

Status of projects.	Number and length of project. ¹							Liability. ²					
	Roads.				Bridges.		Total (duplications eliminated).	Federal.	Local authority.	Total.			
	Survey.		Survey, construc- tion, and maintenance.		Construction and maintenance.						Proj- ects.		
	Num- ber of proj- ects.	Mileage.	Num- ber of proj- ects.	Mileage.	Num- ber of proj- ects.								
						Miles.							
Approved during fiscal year: Under agreement..... No agreement..... Total	22	507.98 237.50	29 18	508.89 142.60	16 43	384.31 350.53	1 4	67 73	1,016.87 379.10	893.20 493.13	\$3,528,941.35 537,144.87	\$2,892,551.11 51,800.00	\$6,421,492.46 588,944.87
	30	745.48	47	651.49	59	734.84	5	140	1,395.97	1,386.33	4,066,086.22	2,944,351.11	7,010,437.33
	29	852.68 237.50	65 18	1,215.23 142.60	19 43	435.03 350.53	1 4	109 73	2,067.91 379.10	1,650.26 493.13	4,994,218.67 537,144.87	4,402,024.44 51,800.00	9,396,243.11 588,944.87
	37	1,090.18	83	1,357.83	62	785.56	5	182	2,447.01	2,143.39	5,531,363.54	4,453,824.44	9,985,187.98
	Total												

¹ Does not include 10 per cent projects completed prior to Jan. 1, 1919.² Does not include small administrative cooperative roads and trails; see text.

In addition to the projects shown in the above tabulation, \$36,700 of the 10 per cent fund and \$650,000 of the Post Office act fund was allotted to the various States for expenditure upon miscellaneous small projects needed for the administration, protection, or development of the Forests.

At the beginning of the fiscal year there was available for road and trail construction on the National Forests \$3,857,178.69, derived as follows:

Agricultural appropriation for the construction and maintenance of permanent improvements.....	\$400,000.00
Ten per cent appropriations for the fiscal year 1919.....	350,533.75
Unexpended balance of 10 per cent appropriations preceding years....	302,801.39
Appropriations for the fiscal year 1919 under section 8 of the Federal aid road act.....	1,000,000.00
Unexpended balance of section 8 appropriation for preceding years....	1,803,843.55
Total.....	3,657,178.69

From the appropriation made available by section 8 of the Post Office appropriation act of February 28, 1919, \$3,000,000 was made immediately available. The unexpended balance in this fund on June 30, 1919, was \$2,966,939.41, showing an expenditure of \$33,060.59. The unexpended balance for the 10 per cent fund on the same date was \$374,289.51 and for the section 8 fund \$2,296,499.18, showing an expenditure from these funds of \$279,045.63 and \$507,-344.37, respectively.

The following tabulation shows the additional amounts available on July 1, 1919, for National Forest road and trail work. The 10 per cent fund must be spent within the State from which National Forest receipts were obtained, and can not be expended outside of the Forest boundaries. Cooperation is not essential. Cooperation must be secured before any section 8 money can be expended; but projects need not be located entirely within the National Forests. With the exception of the amount set aside for administrative expenses, for the purchase of equipment, and for increasing the apportionment to States, the entire yearly appropriation is apportioned to separate States and groups of States and can not be diverted to different States except under extraordinary conditions. The appropriation made available by the Post Office appropriation act of February 28, 1919, and commonly termed the Federal Forest road construction appropriation, may be spent for projects located within or partly within the National Forests of any States. The provision relative to cooperation has already been explained. Tentative apportionment of the appropriation is made on the basis of the relative need of road development and of the most important road projects in the several States, and determination is made of the conditions upon which any project will be approved. If the conditions are not met, the money tentatively set aside for any project is available for use elsewhere in the State or in some other State.

Amounts available for roads and trails from new appropriations available for expenditure on July 1, 1919.

State.	10 per cent.	Section 8.	1920 Federal Forest road construction.	State.	10 per cent.	Section 8.	1920 Federal Forest road construction.
Alaska.....	\$10,182.71	\$46,717	\$29,500.00	Alabama.....	\$49.23		
Arizona.....	45,261.18	54,311	117,371.00	Georgia.....	419.99		
Arkansas.....	6,625.55	10,102	53,000.00	Maine.....	178.60		
California.....	51,703.89	140,297	284,865.00	New Hampshire.....	1,972.01		
Colorado.....	46,019.59	63,541	215,385.33	North Carolina.....	2,223.78	\$27,684	\$133,000.00
Idaho.....	46,307.04	104,474	338,039.50	South Carolina.....	88.15		
Montana.....	38,017.13	71,481	222,185.00	Tennessee.....	853.67		
Nevada.....	12,275.36	19,005	45,212.00	Virginia.....	1,313.26		
New Mexico.....	33,864.42	37,684	123,162.50	West Virginia.....	95.51		
Oregon.....	46,162.30	131,825	303,871.00	Special fund ¹		100,000	
South Dakota.....	6,713.76	7,946	20,427.17	Equipment.....			95,000.00
Utah.....	27,460.25	39,072	141,437.00	Administrative expenses.....			155,000.00
Washington.....	21,909.03	92,153	202,237.50	Unallotted balance.....			242,307.00
Wyoming.....	23,420.37	41,379	224,750.00				
Florida.....	1,630.31	12,329	53,250.00	Total.....	427,954.75	1,000,000	3,000,000.00
Michigan.....	58.69						
Minnesota.....	1,177.70						
Nebraska.....	1,440.40						
Oklahoma.....	530.87						

¹ For administrative expenses of Bureau of Public Roads and Forest Service, for purchase of equipment, and for increasing apportionment to States.

Section 7 of the act of February 28, 1919, authorized the Secretary of War in his discretion to transfer to the Department of Agriculture surplus war materials, equipment, and supplies suitable for use in road improvement. Ten per cent of the amount so transferred was made available in the discretion of the Secretary of Agriculture for use in the National Forest road work. While only a very small amount of road equipment, material, and supplies has been received, it is expected that within the coming year great assistance will be given the National Forest work by the transfer of material which would otherwise have to be purchased.

The new construction of improvements of all kinds comprised 328 miles of roads, 833 miles of trails, 885 miles of telephone lines, 78 miles of fire lines, 35 lookout structures, 35 bridges, 284 miles of fences, 510 dwellings, barns, and other buildings, 12 corrals, and 202 water improvements. The above figures include 203 miles of roads, 96 miles of trails, 110 miles of telephone lines, 148 miles of stock fences, 6 miles of fire lines, 1 bridge, and 1 water improvement built in cooperation with communities, associations, and individuals.

The value of all improvements on the National Forests at the close of the year constructed from funds derived from congressional appropriations and the contributions of cooperators is estimated at \$8,703,736. Of this amount, \$6,466,014, or 74.3 per cent, represents works of communication and protection; \$1,935,451, or 22.2 per cent, improvements used in administration, and \$302,271, or 3.5 per cent, range improvements. The lines of communication within the Forests constructed by or under the direction of the Forest Service now total 3,620 miles of roads, 26,840 miles of trails, and 254,00 miles of telephone lines.

COOPERATION WITH STATES.

While the forest fire protective systems maintained by the States in cooperation with the Federal Government have been extending, there has also been a recent greatly increased cost of operation. The appropriation of \$100,000 is now very inadequate.

Expenditures from the Federal appropriation, and the expenditures of the States which have entered into cooperative agreements, are shown in the following table. The area protected was much greater than ever before. This was made possible by the fact that the cooperative funds contributed by States and private owners were greater than in 1918. The Federal fund was of course the same as in 1918.

Cooperative expenditures from Federal appropriation and by the States for protecting forested watersheds of navigable streams from fire.

State.	Expenditure fiscal year 1919.			State.	Expenditure fiscal year 1919.		
	Federal.	State.	Total.		Federal.	State.	Total.
Maine.....	\$7,296.73	\$125,893.03	\$133,189.76	Wisconsin.....	\$4,023.63	\$16,261.44	\$20,285.07
New Hampshire.....	6,551.23	23,218.58	29,772.81	Minnesota.....	8,807.32	56,519.39	65,326.71
Vermont.....	2,217.62	2,158.67	4,376.29	South Dakota.....	282.00	4,988.00	5,270.00
Massachusetts.....	3,291.50	32,781.52	36,076.02	Montana.....	2,499.95	8,905.38	11,405.33
Rhode Island.....	92.25	4,097.53	4,189.78	Idaho.....	4,565.34	46,229.73	50,795.07
Connecticut.....	1,025.00	5,217.10	6,242.10	Washington.....	9,692.63	37,162.26	46,854.89
New York.....	7,221.98	117,131.08	124,353.06	Oregon.....	10,210.16	24,966.72	35,176.88
New Jersey.....	1,968.90	20,743.92	22,712.82	Administration and inspection.....	7,140.49	.....	7,140.49
Maryland.....	2,521.65	3,819.95	6,341.60	Total.....	99,921.38	625,445.54	725,366.92
Virginia.....	2,725.34	3,259.83	5,985.17	Unexpended balance.....	78.62	.....	.....
West Virginia.....	4,005.00	9,140.40	13,145.40	Appropriation.....	100,000.00	.....	.....
North Carolina.....	1,207.16	2,433.77	3,640.93				
Kentucky.....	2,429.00	5,538.22	7,967.22				
Louisiana.....	2,581.00	9,451.83	12,032.83				
Texas.....	3,276.00	4,609.20	7,885.20				
Michigan.....	4,280.50	60,917.99	65,198.49				

An agreement entered into with Rhode Island made that State the twenty-third to enter into cooperation. Toward the end of the fiscal year California requested cooperation, but the agreement had not been completed when the year closed.

Protection from forest fires is the first essential to forest conservation. Without an organized and efficient system, such as can be maintained only with adequate regular appropriations, the forests can not be made safe. No better proof of this could be given than the situation which arose in Minnesota in the fall of 1918, when a large number of relatively small fires burned for weeks because of lack of men and equipment to extinguish them, and finally came together in five large conflagrations, according to the State Forester, which in the aggregate swept over not less than 200,000 acres, destroyed property worth about \$25,000,000, and caused a loss of more than 400 lives. Estimates based on forest fire statistics collected in cooperation with State and private agencies indicate that in the calendar year 1918 not less than 25,000 fires occurred, with an area of fully 10,500,000 acres burned over and a financial loss in timber, young tree growth, and improvements of about \$40,000,000. Railroads caused approximately 18 per cent of the fires, brush burning and campers each 13 per cent, lightning 10 per cent, incendiaries 9 per cent, miscellaneous causes 7 per cent, lumbering 5 per cent, and unknown causes 25 per cent.

The States of Alabama, Florida, Georgia, Idaho, Illinois, Maine, Massachusetts, Montana, New Hampshire, North Carolina, Tennessee, and Texas received assistance during the year in formulating forest policies, drafting forestry laws, and the like.

RESEARCH.

INVESTIGATIONS IN FOREST PRODUCTS.

From many standpoints the fiscal year 1919 was the most important in the history of the Forest Products Laboratory. Not only were many of the research projects started earlier in the war brought to a productive conclusion, but the peace-time application of their results was aggressively undertaken through widespread dissemination of the information and through personal contact with the wood-using industries.

During the first months of the year the laboratory was engaged exclusively on special war problems. Cooperation with the various bureaus of the War and Navy Departments which had provided special allotments was at its height, and requests from these departments had become increasingly specific. After the armistice was signed it was necessary to reduce the staff from 458 to approximately 300 persons and to discontinue some of the less important investigations. In accord with the desires of the War and Navy Departments, however, the more important projects which were nearing completion, or which were of special value, were continued. A number of new research projects were begun, but the year's accomplishments were, primarily, the outgrowth of fundamental research begun earlier in the war or prior to the beginning of the war.

Aircraft problems continued to occupy the position of greatest importance. The large fund of available data on wood, plywood, and glues found direct application in the solution of specific problems arising from time to time in the design of aircraft. Many requests were received from the War and Navy Departments for the development of various aircraft parts which could not well be designed without actual tests. Much of this work developed as a result of the successful design by the laboratory of a plywood wing rib for one of the Army planes.

Ribs for almost a dozen different types of Army and Navy planes were designed and tested by the laboratory and gradually improved to the point of maximum strength and minimum weight. These ribs were, in all cases, decidedly superior to commercial ribs of corresponding sizes. In addition to the specific design of these ribs, general laws governing the types of ribs to use for different sizes were developed, and several excellent types of large ribs perfected.

The design of airplane wing beams presented many complicated problems, and the laboratory was called upon to conduct elaborate series of tests on full-sized members to determine the relative merits of the many different types. The growing scarcity of suitable aircraft woods, demanding closer utilization of existing supplies, made it necessary to develop types of built-up beams which would permit the use of small and short stock. Tests were made upon several hundred beams of a number of different types, and several types were developed to meet the specific requirements involved.

Exhaustive tests were also made upon many different types of beam splices, and their relative efficiency was determined. As an

integral part of these tests, the efficiency of various kinds of hide and casein glue was determined. Later in the year, assistance was requested in the design of a wing beam, or the development of a type suitable for very large machines, with spans of 125 feet or more. Special series of tests were made for this purpose, and a type was developed which embodies sound mechanical principles and is remarkably light for its strength.

Much specific information was needed by the Army and Navy in regard to the struts being used on various machines, and comprehensive tests were made by the laboratory upon various kinds and sizes. These resulted in the development of two noninjurious methods of testing struts, whereby the actual strength of each strut could be determined without injuring it. Machines for the proper carrying on of these tests were also developed, and specifications for the inspection of struts by this means were prepared. This method of test is unique, in that there are no other types of structural members which can be tested to their maximum load without injury. In addition, methods for the calculation of the strength of tapered struts and for the determination of the taper which would give the maximum efficiency were developed.

An entirely different kind of investigation was undertaken by the laboratory to develop a type of strut for extremely large flying machines. A radical departure was made from all accepted types of airplane struts, and a type selected which years of experience in the construction of buildings and bridges had proved to be very efficient in long light columns. This type was then modified to suit aircraft needs, and developed to a point where it was much stronger for a given weight than any other type of strut which has so far been developed. Wind-tunnel tests on models specially constructed for the purpose showed that the air resistance of this type is less than that of any other type so far tested.

Elevator and aileron spars, which are the main structural members of airplane control surfaces, are subjected to a peculiar kind of stress known as combined bending and torsion, and their design has always been a matter of guesswork. In the case of small machines this method of design appeared to be quite satisfactory, but in the design of radically new types of great size need was found for accurate data on the design and also for a better type of spar, which would be both stiffer and stronger for the same weight. Through a unique combination of hollow wood and veneer construction, it was possible for the laboratory to improve the spars to a marked degree, both in strength and in stiffness. As a result of this development, the laboratory was finally requested to design a complete control surface, embodying this new type of spar.

Numerous and varied other aircraft developments were carried out, among them being the development of a flexible plywood for control surfaces and of a special mechanism for the proper operation of these surfaces. This plywood and the control mechanism are in process of being fitted to one of the fastest machines developed during the war.

One of the major lines of research was the determination of the effect of various kiln-drying schedules upon the properties of aircraft woods and substitutes for them. Exhaustive tests have furnished conclusive evidence that under proper control of temperature and humidity kiln-dried material of these species is as strong

as air-dried lumber. They show further that the kiln-drying schedules recommended by the laboratory at the beginning of the war and based upon the incomplete data then available were in every sense dependable and are subject to practically no material changes. Up to the date of the armistice, assistance had been given in the design, installation, and operation of 325 Forest Service water spray kilns installed in 44 manufacturing plants throughout the country, including installations at the Government cut-up plant of the Spruce Production Division, and at the Rock Island Arsenal. At the latter plant a laboratory representative demonstrated that artillery wheel dimension oak, green from the saw, can be kiln-dried with insignificant loss in from 60 to 90 days as against 3 to 5 years of air seasoning. This was contrary to previous commercial experience. Other kilns were designed for use at Government arsenals, aircraft factories, gun manufacturing plants, and vehicle plants. The Signal Corps dry kilns at Vancouver, Wash., were started in June, 1918, under the personal supervision of a kiln expert from this laboratory. The first kiln load of airplane wing beams was taken out on July 16. Thereafter the kilns were continuously operated at full capacity of about 40,000 feet per day until the end of the war. A corps of kiln experts was maintained in the field to assist vehicle, furniture, and aircraft manufacturers in the adaptation and operation of commercial kilns used in war work, and intensive courses of training for Government and commercial dry-kiln operators and inspectors were continued until the armistice was signed.

The total number of laboratory strength tests was brought up to over 300,000. About 23,000 strength tests were completed on 32 species of plywood, to determine the strength variation with different combinations of species, number of plies, and ratios of core to total panel thickness. Many additional tests were made to determine the relative amount of warping of various species of plywood, the bending strength and methods of fastening, the relative strength of rotary, sliced, and sawed veneer, and the shearing strength and shrinkage of plywood. Other tests were made on various aircraft parts of plywood, laminated, and fabricated material, such as engine bearers, struts, landing-gear disks, wing ribs, elevator spars, etc. Determinations were made of the mechanical properties of thin plywood for use as a linen substitute, and the relative efficiency of various types of riveted and scarf joints was investigated.

Tests conducted for the War Department made possible great improvements in overseas shipping containers, and many inspectors were trained in the fundamentals of box construction, for manufacturing and export inspection work. Wood preservative specifications were prepared for the Emergency Fleet Corporation and for the Railroad Administration. To assist the latter in its program of preservative distribution made necessary by the shortage of creosote, substitute preservatives were tested and recommendations as to their use were made.

Studies were completed of the effectiveness of various methods of coating and finishing wood to prevent the passage of moisture. Improved methods of finishing with varnishes were developed, and it was shown that protective coating with thin sheets of aluminum leaf is practically 100 per cent efficient. In an experimental shipment of airplane propellers from this country to France those treated by

the aluminum-leaf process developed at the laboratory were the only ones to arrive in satisfactory condition. This method has been officially adopted by the Army and Navy.

The experimental study of the conditioning and manufacture of airplane propellers began to yield information of great value. At the completion of the study it will be possible to specify accurately the species of wood and the manufacturing conditions for the production of the most efficient propellers for the many kinds of service.

A number of new and greatly improved formulas for making waterproof glues for plywood manufacture were developed. One of these for casein glue shows about double the water resistance of the available commercial casein glues and is very resistant to molds. The specifications of the Army and Navy for all glue and glue ingredients were prepared at the laboratory. Much of the work on glues was carried on for the purpose of preparing these specifications. Several commercial concerns have adopted the laboratory glues in production. Numerous improvements were discovered in plywood manufacture that have also been successfully adopted in production.

There were identified 30,863 samples of wood, including some foreign woods, and many microscopic examinations for decay and defects were made. Information illustrating defects in wood was collected, and an illustrated key for distinguishing true mahogany from so-called mahoganies was prepared for propeller inspectors. Studies were made of the effect of moulds on wagon and airplane woods, and of the effect of steam bending on the structure of wood.

Active work on the value of various woods for paper manufacture was discontinued during the war to devote more time to pressing war problems. However, a reliable method for determining the tearing strength of paper was developed. A recording density hydrometer was invented which will be of considerable use in the control of the soda recovery of sulphate and soda pulp mills, acid making in sulphite mills, mixing in the manufacture of ledger, bank-note, and other fine paper, and in the chemical and textile industries in general. The value of waste hemlock bark from paper mills as a source of tannin was also demonstrated. Methods for the production of soda and sulphate pulps suitable for nitrating and for rendering sulphite pulps suitable for this use were developed.

Shortly after the armistice was signed the Salvage Board of the Ordnance Department requested the laboratory to determine the suitability of second-cut cotton linters and hull fibers for paper manufacture. The War Department had on hand at that time a large tonnage of these linters reserved for the manufacture of nitro-cellulose and was seeking the best means of disposing of the surplus. Commercial pulping trials and paper runs made at the laboratory soon demonstrated that second-cut linters and hull shavings can be pulped with decidedly less chemical and bleach consumption than wood, and that they are excellently adapted for the production of high-grade book, writing, blotting, tissue, and other papers. These experiments may well have a far-reaching economic influence on the future of the paper supply of this country. Arrangements have been made for a practical mill trial where the value of this raw material can be demonstrated on a tonnage basis under average mill conditions.

The laboratory cooperated with the Chemical Warfare Service of the Army in gas defense work and developed an artificially dense wood charcoal practically the equal of coconut-shell charcoal. A

suitable gas-mask filter for the removal of solid particles was evolved and tested. Experiments were conducted also on various phases of gas offense.

The threatened shortage of wood pitch for filling the seams of wooden vessels led to experiments with various kinds of mineral pitches, and an experimental deck is now undergoing exposure tests. Several of the mineral pitches seem to be satisfactory.

The readjustment of the laboratory's work to a peace-time basis has included:

(1) The adaptation and application of the data and information obtained during the war to the Nation's industries on a normal peace-time basis.

(2) Analysis of special reconstruction problems and the extent to which the laboratory could be of assistance in solving them.

(3) Consideration of prewar projects and the advisability of resuming them or of starting new researches which appeared of greater importance from a broad reconstruction standpoint.

An illustration of the peace-time application of research conducted in connection with a specialized war project is found in the work of the propeller section. It was soon seen that the developments worked out in relation to the conditioning of wood and the use and formulas of waterproof glues had a far wider field of application than merely to airplane propellers. Following the armistice, therefore, experiments were started in several different lines of built-up construction where possibilities for the utilization of small pieces and waste material existed. Sets of bowling pins, shoe lasts, hat blocks, wagon bolsters and tongues, and other articles were made of laminated material and tested in actual use. These tests in most instances already indicate that the laminated construction for such articles will be practically as serviceable as solid material.

As a result of the war there has been a very marked stimulation in and acceptance of the value of research in forest products, and the requests for cooperation and assistance which have come to the laboratory from many different industries have more than taxed the organization. It has, in fact, become necessary to decline cooperation in a great many instances on account of the inability of the decreased force to carry on the work. There is now open to the laboratory a tremendous field of research of great economic and industrial value.

Close relations were maintained through an office of Forest Products in Washington with the various branches and offices of the War and Navy Departments located in Washington and needing the cooperation of the forest products organization, and also with the War Industries Board, the War Trade Board, the Shipping Board, the Emergency Fleet Corporation, the British and other Allied commissions, and various commercial organizations and associations having to do with war activities. In this way it was possible to furnish data and information on which immediate decision relating to the purchase, storage, or use of timber could be made. Much assistance was given in the preparation of specifications for making purchases of forest products for construction purposes, vehicles, boxes, airplane material, etc., and in the inspection of timbers for ships, airplanes, and docks. Extensive files covering a wide range of data on forest products were maintained for

quick reference. A large volume of statistical data was furnished for the use of foreign governments. The figures on production and consumption in many instances served as a basis for reaching conclusions on problems of utilization, substitution, and regulation of imports and exports.

After the armistice was signed arrangements were made to continue cooperation with the Bureaus of Construction and Repair and Steam Engineering of the Navy and with the Air Service and Bureau of Ordnance of the Army, and for the completion of many projects which will yield information useful in peace as well as war. Recognition of the fact that the Forest Service is an authoritative source of information on forest products and their uses has put the office in a position to render considerable assistance to various departments.

FOREST INVESTIGATION.

Under "forest investigations" are included a wide range of studies. Some of them have for their purpose better knowledge as to the amount, character, and distribution of our present forests; others concern the demands made upon them for the supply of material of various kinds, probable future demands, and the methods of utilization; and still others seek to make possible better methods of utilization and the most beneficial contribution of our forest resources to the public welfare, through investigations basic to the successful practice of forestry. The studies are therefore partly economic and industrial, in which case they have to do largely with the gathering and interpretation of statistics of production, consumption, present timber stands, and similar matters, and partly woods studies of all the factors which control or affect forest establishment, renewal, composition, rate of growth, and character of material produced.

During the past year the forest investigations have been chiefly those connected with war activities and with the completion of the work started during the war. Many such investigations which were in their midst when hostilities ceased called for completion because of the applicability of their results in the post-war period. Thus the study of the amount of black walnut available for airplane construction and for gunstocks was completed, and a publication prepared dealing with supplies, growth, and management of this valuable species. A summary report was also prepared of the available supplies of the kinds of timber most likely to be used in aircraft construction during peace time. The study of supplies of the most important timber species has furnished a good deal of knowledge of our timber resources which have distinct value as a basis for shaping measures aimed to secure perpetuation of these supplies, pending provision for a complete timber inventory such as is fundamental to the working out of a sound, thoroughly intelligent forest policy for the Nation. The requirements of the Government for forest products, together with the control of production for needs of the country not directly connected with the prosecution of the war, gave a more accurate conception of the broad situation in which we are placed regarding forest products. This, together with inquiries as to the timber situation in foreign countries, afforded a clearer perspective of how far our own forests can be expected to meet future domestic and foreign needs.

A few investigations were undertaken having directly in view the meeting of postwar problems. Because of the importance of Sitka spruce for aircraft production, a study was undertaken of its growth, yield, and management.

Because of the added importance, in view of renewed agitation of the national need for the practice of forestry on private lands and of a comprehensive program for securing the perpetuation of our forest resources through combined public and private action, of accurate data as to the growth and yield of the different types of forest and the costs that may be involved in securing forest replacement, many field measurements were restudied in the light of recent experience and new data were accumulated. While the facts available are sufficient upon which to base a plan for inaugurating a general policy, the actual carrying out of such a policy will demand the prosecution of forest studies more comprehensive and far more detailed than those hitherto undertaken if the plan is to be made to work fully.

Some of the fundamental prewar studies, such for instance as the relation between distribution of the different forest types and the climatic and soil factors that control them, the importance of farm woodlands in the economic management of the farm, studies of the physical, chemical, and biological properties of seed, studies of the causes of forest fires and the liability of different forest types to them, have been renewed and are to be pushed with vigor to completion. As a partial provision for meeting the need for fuller information relating to the proper handling of forests, a comprehensive scheme for forest investigation in cooperation with States and forest schools has been developed.

MISCELLANEOUS.

Thirty-seven new publications were issued. The distribution of Forest Service publications totaled 316,000 copies. About 62 addresses were made, mainly at expositions and upon requests from National Forest users, lumbermen's associations and similar trade bodies, technical societies, and educational institutions. Lantern slides were loaned to more than 208 persons engaged in educational work. These were shown 422 times and to 10,293 persons. Additions to the photograph collection totaled 1,154 and to the lantern-slide collection 1,186; and 924 lantern slides, 29 transparencies, and 472 bromide enlargements were colored. Traveling exhibits of photographs, maps, drawings, and wood samples were loaned to 128 schools and libraries. Through sales, loans, and gifts 4,890 individual photographic prints were made available for outside illustrative purposes.

Additions to the Service library in Washington totaled 765 books and pamphlets. The index of forest literature was extended by entries covering 2,725 books, periodical articles, and manuscripts. Loans from the library totaled 2,883 books and 5,841 periodicals. The 162 branch field libraries now contain 31,602 books recorded in the main library, besides various State and other publications not so recorded.

REPORT OF THE CHEMIST.

UNITED STATES DEPARTMENT OF AGRICULTURE,

BUREAU OF CHEMISTRY,

Washington, D. C., October 11, 1919.

SIR: I submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1919.

Respectfully,

C. L. ALSBERG, *Chief.*

Hon. D. F. HOUSTON,

Secretary of Agriculture.

As last year was a year of readjustment within the bureau to meet the demands for assistance made by the Government's war machine, so this year has been one of return to the normal. During the war so much unusual work was required of the bureau that its momentum was temporarily checked, and it had to be content to keep the regulatory work as nearly as possible up to its prewar level. It could not hope to forge ahead. Since the armistice was signed, the bureau has gradually regained its prewar acceleration, with the result that, though four months of the year were war months, and though the armistice did not by any means halt work for the war agencies or make it possible to recruit the bureau's force up to its normal strength, nevertheless 1,133 recommendations for criminal prosecution and 1,052 for seizure alleging violation of the Food and Drugs Act were sent to the Solicitor—by far the largest total for any one year in the history of the enforcement of the Food and Drugs Act. This is not to be taken to mean that the war has lowered the ethics in this country of the food and drug producing industries as a whole, although it has increased sophistication and misbranding in certain special directions. It merely shows that the bureau's regulatory force is gaining in efficiency as it gains in experience, and that the gradual reorganization of the bureau, the evolution of which has been recorded in its reports from year to year, is bringing results.

While the regulatory force of the bureau, despite the depletion of its personnel, is performing a greater volume of work than ever before, the constructive research work has not yet returned to normal. Partly completed war research problems have had to be rounded out, that the time and effort originally expended upon them might not be wholly lost. Moreover, the lure of high salaries is stronger than ever, so that there has been a heavy drain upon the bureau's force through the passing of men from it into the industries. The totally inadequate salaries offered by the Government have made it impossible to fill suitably the gaps thus created. From July 1, 1917, to June 30, 1919, of the war period, the separations from the service, not including men who entered the military service, have been of the technically trained staff 39 per cent of the prewar strength of the bureau, of the clerical staff 68 per cent, and of the staff of laborers,

mechanics, messengers, and the like, 90 per cent. The total separations from the whole bureau, the so-called "turnover," including men furloughed to enter military service, for the two-year period, has been 72 per cent, and there is no indication that conditions are improving. It is obvious that service in the bureau must be made more attractive, especially in its financial aspects, if such efficiency as the Bureau of Chemistry has been able to achieve in the past is to be maintained.

Nevertheless, the momentum of the bureau's research organization has been sufficient to produce a larger number of publications than ever before. There were issued nine department bulletins, two department circulars, two circulars of the office of the Secretary, and one yearbook article. In addition, the results of more than 75 investigations were made public, and those of more than 25 are now in press. The experimental work upon a number of other investigations has been completed. Thirty-five applications for patents were filed, of which 14 were allowed, 6 disallowed, and 15 are pending.

Naturally the work demanded of the bureau by other branches of the Government has lessened since the armistice; but its volume is still considerable. There is every indication that, inasmuch as the war brought to the attention of other branches of the Government the services the bureau is capable of rendering, such collaborative work will never diminish to the prewar volume. It is essential, therefore, that adequate funds for such collaborative work be provided. Moreover, the growth of the bureau in the last 10 years has been such that the quarters available in Washington have long been inadequate, and if its work is not to be progressively crippled, suitable quarters must be provided.

ENFORCEMENT OF THE FOOD AND DRUGS ACT.

DOMESTIC FOODS AND DRUGS.

One thousand and fifty-two recommendations for seizure and 843 recommendations for criminal prosecution were made to the Department of Justice, through the Office of the Solicitor. Table 1 gives a list of the classes of products on which action was recommended to the Solicitor, and also the distribution of the recommendations among the various types of products.

TABLE 1.—*Recommendations of action on alleged violations of the Food and Drugs Act transmitted to the Solicitor.*

Product.	Criminal actions.	Seizures.	Product.	Criminal actions.	Seizures.
Beverages, extracts, flavors.....	21	15	Lard and lard substitute.....	2	.....
Candy.....	1	.....	Meat and poultry.....	20	3
Chocolate and cocoa.....	3	16	Nuts.....	.....	4
Coffee and tea.....	2	1	Oil, olive, salad, etc.....	193	130
Colors, food.....	8	.....	Oranges.....	.....	43
Dairy products.....	141	51	Preservatives.....	1	.....
Drugs, crude, and pharmaceutical preparations.....	47	37	Sea foods.....	19	39
Drugs, remedies.....	122	513	Sirups.....	11	1
Eggs and egg substitutes.....	48	23	Spices and relishes.....	.....	17
Feeds.....	306	27	Tomato products.....	50	44
Flour, grain, alimentary pastes...	16	6	Vegetables.....	9	18
Fruits.....	19	7	Vinegar.....	35	9
Gelatin.....	40	25	Water.....	15	16
Glycerin.....	.....	1			
Jam, jelly, and marmalade.....	4	6	Total.....	1,133	1,052

Examination of Table 1 shows that action was recommended most frequently against shipments of patent medicines, crude drugs and pharmaceutical preparations; of mineral waters and nonalcoholic beverages; of shell eggs and egg substitutes; of dairy products; of gelatin; of olive oil; of oranges and tomato products; of sea foods; of cacao products; of vinegar; and of stock feeds.

In the patent medicine cases, it was alleged usually that they were misbranded as to therapeutic claims under the Sherley amendment. In the case of the crude drugs and pharmaceuticals it was usually alleged either that they did not comply with the requirements of the United States Pharmacopœia and were not labeled to indicate wherein they differed from the standard of the Pharmacopœia, or else that they were otherwise misbranded or adulterated.

In the mineral water cases it was alleged, as a rule, that they were either polluted or misbranded as to therapeutic claims under the Sherley amendment, or both.

The expansion of the nonalcoholic beverage industry has made necessary a close supervision of this class of products. Among the various kinds of violations alleged the most common are based on the representation by the manufacturer that the products consist in whole or in part of fresh fruit juice, when, in fact, they contain only some organic acid and an artificial flavor. Some of these products were found to contain saccharin substituted in whole or in part for sugar.

The work on shell eggs was in the nature of a follow-up campaign of the action taken in previous years and described in the Report of the Chemist for 1918. The eggs arriving in the market continue to improve in quality. The action against egg substitutes is the outcome of the work inaugurated and described last year.

The investigation of dairy products was designed to continue the supervision of evaporated and whole milk received in interstate or foreign commerce. In addition it was found that the high price of butter stimulated its adulteration with water or salt, or both, so as to lower the fat content. Much attention has been devoted to putting a stop to this practice.

The work upon gelatin was a continuation of that described last year to suppress the sale of glue as edible gelatin.

The olive oil cases were brought in conformity with the campaign inaugurated in 1918 to prevent the adulteration with other edible oils of olive oil, which is still practically unobtainable from Italy, although it can be secured from other Mediterranean countries, notably Spain. In consequence, much Spanish olive oil of excellent quality has been misbranded as Italian oil, a practice which it has been attempted to abolish.

The work upon oranges, necessitated by the disastrous frost of last winter, was designed to prevent the sale of frozen fruit. Frozen oranges should be used for the preparation, near the point of production, of jams and preserves, for which they seem suited if used promptly.

While a number of cases have been made against tomato products, the quality of these products as a whole continues to improve vastly. The adulteration of canned tomatoes with added water is becoming rare, and less tomato pulp made from partially moldy or fermenting

stock is being produced. Assistance continues to be rendered by the experts of the bureau to manufacturers through personal visits.

The work upon sea foods was confined largely to the adulteration of oysters and scallops with water, termed "soaking" by the trade, the slack filling of cans with shrimp, and the prevention of the sale to the consumer of stale or tainted canned salmon. The latter project occupied more of the time of the regulatory force of the bureau than any other, since it involved the examination in detail of the vast surplus stores of canned salmon held by the Army before they were permitted to be turned back into the ordinary channels of trade.

The cases upon cacao products dealt principally with the adulteration of cocoa with cacao shells.

The cases upon vinegar were of the usual type. A new method has been developed for the identification of waste apple products vinegar by means of which it is hoped that the traffic in this variety of vinegar may be controlled and forced on to a legitimate basis.

The cases against stock feeds comprised the usual types of adulteration and misbranding reported from time to time in previous years. Much attention was paid to rice mill by-products, especially the adulteration with rice hulls, and data were obtained upon the conditions prevailing in the rice mills of the Pacific coast and upon the use of lime in rice milling. It was also found that, owing to the difference in price between bran and shorts, certain manufacturers were selling finely ground bran as shorts.

Of the 1,019 cases of all kinds reported to the department as terminated in the courts during the year, 258 alleged false and fraudulent labeling of medicines, 22 alleged similar misbranding of veterinary remedies, and 56 alleged adulteration or misbranding of stock feeds. All in all, 3 cases were reported as decided unfavorably to the Government.

Among the cases terminated was the bleached flour case which was pending at Kansas City, Mo. (N. J. 6380). The libel was amended to strike out the allegation to the effect that the flour contains an added deleterious ingredient which might render it injurious, in view of the experimental work of the bureau which did not indicate that the allegation was tenable under the interpretation of the law by the U. S. Supreme Court (N. J. 3398). The claimant then withdrew appearance and answer, and a default decree of condemnation and forfeiture was entered as to the remaining allegations in the libel.

Publication has been made of two judicial decisions of interest, involving interpretation of the law. The U. S. Supreme Court, in a judgment reported in Notice of Judgment 6308, affirmed judgment of the lower courts against Oscar J. Weeks, doing business as O. J. Weeks & Co., in connection with the misbranding of an article labeled "Special Lemon, Lemon Terpene, and Citral." A salesman of the defendant in offering the article for sale represented it as lemon oil, which it was not. The defendant upon appeal insisted that under the statute the question whether an article is misbranded turns entirely upon how it is labeled when it is shipped, regardless of any representations made by a salesman in offering it for sale. The U. S. Supreme Court, however, held that the statute specifies and defines at least two kinds of misbranding, one where the article bears a false or misleading label, the other where it is offered for

sale under the distinctive name of another article. The two are quite distinct, a deceptive label being an essential element of one but not of the other. The court accordingly ruled that testimony respecting the representations of the defendant's traveling salesman was rightly admitted in evidence and submitted to the jury.

The case reported in Notice of Judgment 6362 is one under the Sherley amendment to the Food and Drugs Act, alleging misbranding of "Dr. J. H. McLean's Liver and Kidney Balm." The Court of Appeals of the Eighth Circuit reversed a judgment of conviction in the lower court because of error in the instructions of the court, and a new trial was awarded. In the instructions to the jury on the question of the fraudulent character of the statements made by the defendant regarding the article, the court inadvertently said that "one who makes a false statement not knowing whether it is true or false is as guilty of wrong as the man who makes a false statement knowing it is false." The Court of Appeals held this portion of the charge was erroneous, as it permitted the jury to find that these false statements were fraudulent although the defendant honestly believed them to be true.

Two hundred and two of the cases reported as terminated were instituted by 38 different State and city agencies, either independently of or in cooperation with the Bureau of Chemistry. In 1916 there were but 35 such cases instituted by but four collaborating agencies. This very great increase illustrates the growing interest of State and city officials in the Federal act as a supplement to city and State food and drug laws. A rather unusual form of cooperation is found in the enactment by the State of California of a law forbidding the sale of arsenic-bearing sulphur for use in the production of food products. This followed the publication by the bureau of a report upon the arsenic content of sulphur from different sources.

To supersede Circular 19, Office of the Secretary, Circular 136, Office of the Secretary, "Standards of Purity for Food Products," was issued. The service and regulatory announcements published during the year contained 25 opinions and 250 notices of judgment. The following food inspection decisions were issued:

No. 177. Soda Water Flavors and Soda, Soda Water.

No. 178. Milk and Cream.

No. 179. Amending Regulation 29, Which Relates to Marking the Quantity of Food in Package Form.

No. 180. Colors in Food.

Nos. 177 and 178 are based upon the recommendations of the Joint Committee on Definitions and Standards.

No. 179 changes the exemption of small packages from those containing 2 ounces or less to those containing one-half ounce or less. This was done to prevent, in so far as existing legislation will permit, deception through the slack filling of small packages, such as 5 and 10 cent packages of spices. To protect the consumer more fully than is possible under existing statutes from fraud through the slack filling of packages, or the use of containers deceptive as to the amount of food in them because of their shape or dress, the department has recommended to Congress an amendment to the Food and Drugs Act. Moreover, independently of or in connection with other charges, consideration has been given to more than 1,000 cases alleging that the

net weight either was not stated on the package or else was wrongly stated. Also numerous investigations have been undertaken to determine the variation in the quantity of the contents of packages of food as the result of the process of packing, as well as from shrinkage in storage and transportation. Such investigations are necessary for the effective enforcement of the net weight amendment.

A very extensive investigation, conducted through two seasons in various sections of the country, to determine the proper fill of cans of fruits and vegetables was carried to a successful conclusion. Based upon the results of this work, announcements of weights which are representative of properly filled cans have been made in the case of peas, unpitted cherries, wax and refugee beans, and peaches.

Food Inspection Decision 180 removed from the list of permitted colors certain ones which had been found unsuitable.

The number of pounds of straight dyes for which certification was asked during the year is as follows: Amaranth, 36,753; Butter Yellow, 3,802; Butter Yellow AB, 333; Erythrosine, 732; Indigo Disulfo Acid, 1,317; Light Green SF Yellowish, none; Naphthol Yellow S, 905; Orange I, 17,142; Ponceau 3 R, 11,832; Sudan I, 2,041; Tartrazine, 38,295. Certification was also asked for 4,750 pounds of re-packed straight dyes and 97,241 pounds of color mixtures.

Table 2 gives the distribution of the official samples examined by the various field stations. In addition, thousands of shipments were examined, hundreds of which involved a preliminary laboratory examination not reported in the table.

TABLE 2.—*Report of field stations for year ended June 30, 1919.*

Station.	Import samples.				Interstate samples.			Miscellaneous samples.	Total samples analyzed.	Hearings.	
	Legal.	Illegal.	Re-leased without prejudice.	Flour inspection samples.	Legal.	Illegal.	Check analysis.			Personal.	By correspondence.
Central district:											
Chicago.....	140	52	39	212	214	504	159	2,819	3,888	50	380
Cincinnati.....	64	1	0	20	121	294	16	261	757	0	259
Kansas City.....	0	0	0	0	3	23	0	23	41	1	83
Minneapolis.....	55	23	0	68	50	135	36	450	749	19	65
New Orleans.....	15	18	0	59	24	66	39	896	1,052	51	202
St. Louis.....	9	28	0	14	87	281	35	738	1,181	85	226
Total.....	283	122	39	373	499	1,303	285	5,187	7,668	206	1,215
Eastern district:											
Baltimore.....	70	10	0	0	129	350	5	723	1,287	3	157
Boston.....	142	102	0	3,586	38	149	6	390	827	83	85
Buffalo.....	140	287	0	289	57	75	0	213	772	221	81
New York.....	2,538	1,329	94	5,801	252	527	21	1,996	6,757	394	784
Philadelphia.....	73	31	0	454	46	171	2	193	509	27	94
Porto Rico.....	201	422	9	554	0	10	0	132	674	415	8
Savannah.....	65	3	5	1	101	252	8	381	826	11	117
Total.....	3,229	2,184	108	10,685	623	1,534	42	4,028	11,652	1,160	1,326
Western district:											
Denver.....	3	13	0	84	37	91	4	486	634	3	27
San Francisco.....	177	297	9	9,760	49	150	23	1,995	2,700	297	90
Seattle.....	136	237	6	6,260	48	89	13	1,211	1,750	194	61
Total.....	316	547	15	16,104	134	330	40	3,692	5,084	494	178
Grand total.....	3,828	2,853	162	27,162	1,256	3,167	367	12,907	24,404	1,860	2,719

A great deal of assistance has been given the Post Office Department in connection with the exclusion from the mails of patent medicines, alleged therapeutic devices, and similar materials, involving work on the part of the bureau very similar, so far as laboratory operations are concerned, to that carried on in the enforcement of the Food and Drugs Act.

IMPORTED FOODS AND DRUGS.

During the fall of 1918, and particularly the three or four months following the signing of the armistice, owing in part to embargoes and to the restriction of imports by the War Trade Board, imports were rather less in volume than at any other previous period. This was more noticeable in the case of food products than in the case of crude drugs, which have been less restricted and have been shipped from original sources to a greater extent than formerly. Disorganization of trade and of shipping, giving rise to delays, has caused many shipments to arrive in a more or less moldy condition. As a result of this disorganization, goods have been shipped before they were properly cleaned, particularly fennel, anise, cumin, caraway, fenugreek, and ajowan seeds, and thyme, savory, sage, and marjoram leaves, which in most instances have been released after proper cleaning. Goods in part moldy have been released after proper sorting and conditioning when this was practicable. A number of shipments of gum karaya, a product recently imported in large quantities, have been released after proper cleaning to remove excess bark or dirt. A chemical method was developed this year for the examination of this gum after grinding and conditioning. Not a few shipments of anise seed have been detained because they were mixed with an appreciable percentage of exhausted seed. In a few instances the poisonous leaves of *Coriaria myrtifolia* have been found in marjoram leaves. Substitution of crude drugs for others better known or for official species has not been uncommon. The following may be noted: Japanese aconite (*Aconitum fischeri* Reich.) for aconite (*Aconitum napellus* L.; red Jamaica or native Jamaica sarsaparilla (*Smilax utilis* Hensley) and the common brake (*Pteris aquilina* L.) for sarsaparilla; *Inula* species and an unidentified product from Mexico for arnica flowers (*Arnica montana* L.); Mexican orizaba root (*Ipomoea orizabensis* Ledeb.) for jalap (*Exogonium purga* Benth.) and for scammony (*Convolvulus scammonia* L.); Asiatic licorice (*Glycyrrhiza uralsensis* Fisch.) for licorice; *Ballota hirsuta* Benth. for horehound (*Marrubium vulgare* L.); Egyptian henbane (*Hyoscyamus muticus* L.) for henbane (*Hyoscyamus niger* L.); *Arum maculatum* L. for *Colchicum autumnale* L.; Egyptian stramonium (*Datura metel* L.) for stramonium (*Datura stramonium* L.); *Ionidium* species for ipecac (*Cephaelis ipecacuanha* Rich.). Maracaibo bark was invoiced as cinchona bark, Peruvian bark, and cascarilla bark.

In other instances official drugs, such as aconite, belladonna, calisaya bark, and hyoscyamus, have been found deficient in alkaloid or active principle. In the case of substitutes or drugs deficient in active principle which may have some legitimate use, the bureau has felt that release on relabeling alone would not effectively prevent the goods from filtering into the channels of trade and being sold ulti-

mately as the official product. A public statement through the service and regulatory announcements has therefore been made that release in such cases will be conditioned not only on proper relabeling but also on definite information that the goods will be manufactured by a specified firm into products for which their use is approved.

Special attention has been given to medicinal preparations bearing statements of therapeutic or curative effect. The printed matter used with each preparation has been carefully reviewed by the bureau's medical staff in Washington, with a view to exhibiting a uniform and consistent attitude toward all such products. Copies of the comments made, with information regarding the labeling, have been transmitted on cards to all the port stations, thereby insuring perfectly uniform action. A distinction has been made between products intended for sale to the general public and those intended for physicians' use which are so labeled as not to affect the general public, properly confining all statements as to therapeutic use to an inclosed circular, leaving the outside label entirely free from such statements.

During 1918 many shipments of dried-egg products, yolk and albumen, coming from China, were found to contain notable quantities of zinc or zinc compounds. Such contamination occurred because these products were dried in zinc or zinc-lined trays, or, in some instances, in large plants, on zinc belts. During 1919 the shipments of yolk, some of them representing large lots manufactured by the spray process, have been found practically free from zinc. In the early part of the year several shipments of albumen were detained because of the presence of zinc, but during the latter part of the year a number of shipments, mostly small in amount but from a number of different manufacturers, have been found satisfactory. This would indicate that several firms in China have so changed their methods of manufacture that they can supply goods free from zinc, and will shortly be able to meet the demand for dried egg albumen and yolk, used in increasing quantities by bakers and manufacturers of bakers' supplies.

The last few months of the year saw the beginning of the resumption of normal trade in foods, notably olive oil, which had been subject to embargo in most countries. Large quantities, almost sufficient for normal demand, have come from Spain, and have caused the price to drop to nearly normal figures. In the past, Spain has furnished directly comparatively little olive oil to this country. The bureau's inspection has shown no instances of adulteration. The first few shipments have also been received of those particular foodstuffs from England, France, and Italy, that normally are imported in large quantities, but which ceased to come in during the last two years of the war. The first shipment of Smyrna figs received since the war began arrived during the last month of the year.

SUGARS, SUGAR DERIVATIVES, SIRUP.

Processes for the preparation of the sugar xylose, of gum industrially valuable as an adhesive, and of other useful substances from corncobs have been patented and made available to the public. Development work now being performed upon these processes offers a

prospect that in time a new industry utilizing corncobs, a by-product heretofore largely wasted, may be established. As such an industry would make xylose available in large quantities, studies on the utilization of this hitherto rare sugar have been undertaken. A relatively simple process for its conversion into gulonic lactone, which might be useful commercially, has been patented and published. Moreover, a large series of bacteria has been found capable of fermenting xylose, to form certain products which may be of value industrially.

Data on the occurrence of the rare sugar melezitose in a manna from the Douglas fir and on the crystallography and optical properties of three aldopentoses have been published. Papers upon the crystallographic properties of melezitose, upon the amide of α -*D*-mannoheptonic acid, and upon the rotatory powers of the amides of several α -hydroxy acids of the sugar group are in press.

The distribution of pure sugars, especially for use in bacteriological research, was more extensive this year than heretofore, varying amounts of 19 different pure sugars having been sent out.

The curtailment of distilling and brewing together with the war-time restrictions placed upon the consumption of sugar, seems to have stimulated the production of barley sugar or maltose, as well as that of maltose sirup. Since the extension of the uses of such material is a matter of some interest to the producer of barley, practical studies on the use of maltose sirup in candy manufacture have been undertaken. Preliminary results indicate that perhaps large quantities of maltose sirup can be employed in this way.

The project on the production of a uniform cane sirup that will neither ferment nor crystallize, which had reached such a stage that the problem was in the main how to introduce and cause to be used the processes devised in the bureau, has received a setback because yeast, necessary in these processes, is now obtainable only with difficulty. A search for substitutes for yeast has therefore been made, and preliminary results justify the hope that certain molds which can be grown easily and cheaply may form sufficient of the enzyme invertase to make it possible to use them instead of yeast for this particular purpose.

The bureau has cooperated with the Louisiana State Experiment Station in the study of the deterioration of raw sugars caused by the action of molds. In the preparation of cellulose acetates and their study, undertaken for the Bureau of Aircraft Production, some new cellulose compounds were prepared. This work has been closed.

FATS AND OILS.

Department Bulletin 769, "The Production and Conservation of Fats and Oils in the United States," giving a digest of the data collected during 1917 and 1918 by the U. S. Food Administration and the Bureau of Chemistry, was issued. This is perhaps the first complete and critical survey of the fat and oil industry and traffic of any country, and as a consequence the demand for the bulletin has been very great. A supplement containing the revised statistics up to January, 1919, is now in press. Hereafter the Bureau of the Census will collect the production, importation, and exportation figures on fats and oils, and issue them in quarterly reports.

The examination of tomato-seed oil has been completed, and the data thus secured submitted for publication.

A survey of the industrial recovery of wool grease has demonstrated clearly the necessity for a systematic investigation, to the end that less of this valuable material be wasted in the process of scouring wool.

CHEMISTRY AND NUTRITIVE VALUE OF PROTEINS.

The physico-chemical examination of gelatin has led to the publication of two articles entitled, respectively, "The Mutarotation of Gelatin and Its Significance in Gelation" and "The Effect of Hydrogen Ion Concentration on the Liquefaction of Gelatin," and to the preparation of a third, entitled "Determination of the Jellying Power of Gelatins and Glues by the Polariscope," which proposes a method for testing gelatins and glues based upon changes in rotatory power.

The basic amino acid, lysin, which is believed to be an essential ingredient of diets capable of supporting growth, was discovered in hordein, the principal protein of barley.

A summary of the work on the proteins of the peanut and a preliminary announcement of the value of peanut flour in wheat bread has been presented. A loaf made from wheat flour with a small admixture of peanut flour and salts furnishes a diet that is biologically complete, is properly utilized by animals, and maintains normal growth. Even smaller amounts of soy-bean meal will give similar results.

The hydrolysis of stizolobin, the globulin of the Chinese velvet bean, *Stizolobium niveum*, has been completed. Two and one-half per cent of hydroxyglutaminic acid and from 9 to 10 per cent of aspartic acid were obtained from it. Rats fed upon a diet containing as the sole source of nitrogen the protein of the Georgia velvet bean grew normally to maturity. Further work is necessary to determine why the bean itself does not sustain growth. As has long been known, the globulin of the navy bean will not support normal growth. The bureau has discovered that if cystine be added to such a diet this protein will support growth. Moreover, normal growth can be obtained upon a diet containing navy beans to which cystine has been added. It also appears that the nutritive value of the globulin is somewhat improved by heating the protein in water. These observations are so suggestive that similar work upon other species of beans will be begun to determine if they, too, are deficient in cystine.

The data showing that coconut globulin contains all of the basic amino acids necessary to growth and that it, as well as crude coconut press cake, is capable of supporting growth, have been presented. It was subsequently found that mixtures of certain corn feeds with coconut press cake produce normal growth, which indicates that the coconut press cake contains sufficient water-soluble vitamins when the diet consists of equal amounts of the corn feed and the press cake. These findings justify the opinion expressed in the Report of the Chemist for 1918 that it is extremely desirable to retain in this country the copra-crushing industry which developed during the war.

SEA FOODS.

Bulletin 740, "A Study of Some of the Chemical Changes Which Occur in Oysters During Their Preparation for the Market," has been issued. It has been discovered that zinc, like copper, is invariably present in oysters, and probably in other mollusca. No relation could be traced between the zinc content of oysters and that of the waters from which they were taken. The data upon which these conclusions are based have been published. At the request of the Bureau of Fisheries a study was made of trade-waste effluents at Bridgeport, Conn., and West Point, Va., to determine the influence of such effluents upon the production of oysters in these localities.

Analyses have been made at various seasons of Pacific coast fishes, the food value of which is not known, and the results will be published when another season's work has been completed. Information on the preservation of Pacific coast sardines by smoking has been disseminated, and a publication on the preparation of salacchini will soon appear. The project to develop methods for the preservation of Pacific coast fish will be discontinued because funds are no longer available.

Bacteriological examination has shown that, as reported last year for Maine sardines, and published this year, the intestines of salmon and certain other fish that are not feeding are practically sterile. Evidently in the spoilage of such fish the bacterial invasion is from the skin inward, not from within the gut outward. Hence knowledge of the resistance offered by the skin of various kinds of fish to invasion by bacteria is of importance in determining the best methods of handling each species. Preliminary data indicate that the skin of different species varies appreciably in this respect. It follows, moreover, that in handling and transporting many kinds of fish it is of the utmost importance to avoid any injury or bruising of the skin.

The changes that take place in the flora of fish during shipment to market or cannery and during cold storage have also been studied, especially the microorganisms found on Pacific salmon. A related inquiry upon an aerobic spore-forming bacillus from canned salmon has been prepared for publication. In addition, search has been made for satisfactory chemical methods to detect spoilage of salmon, and to learn the conditions under which the fish may become stale in the cannery before being packed. While satisfactory progress has been made, at least another year will be required for the completion of the project.

A paper on the determination of the hexabromid and iodine values of the oil of salmon as a means of identifying the species in the canned product has been published.

Progress has been made in the study of the best methods of transporting fresh fish. Some shippers have been induced to substitute for barrels used as shipping containers 100-pound boxes, 30 inches long by 15 inches wide by 15 inches deep. In such boxes the lower layers of fish are not subjected to as much pressure and bruising as in barrels or when shipped loose with ice in the bottom of refrigerator cars. Study has shown that in barrels the pressure upon the lower layer of fish may be so great as to produce a shrinkage of over

8 per cent in five days, whereas the shrinkage in the top layer is practically negligible.

Studies have also been made on the chilling of fish to prevent their rise in temperature while being transported in warm climates to the refrigerator. The preservation of fish by freezing, and especially the freezing of fish in chilled brine, has been investigated. It was determined that in the latter process the brine penetrates through the skin for a short distance.

A large fund of information concerning the commercial handling of fish intended for freezer storage, and on the equipment of fish freezers has been obtained. It has thus been possible to give advice to operators and prospective builders of fish freezers. Many persons in the various branches of the fish industry were given information. Producers on the Maryland, Virginia, North Carolina, and Florida coasts were instructed in the packing of fish and loading of refrigerator cars. In cooperation with the Bureau of Fisheries, the bureau supervised the handling and freight transportation of fish in car lots from the producing section in Florida to Savannah, Ga., Louisville, Ky., Nashville, Tenn., and Indianapolis, Ind. Approximately 400,000 pounds of fish were transported in this way, and in consequence the market for Florida fish was greatly extended. Moreover, in cooperation with the Bureau of Fisheries, analyses of various kinds of salt were made to determine the characteristics of those most suitable for salting fish.

POULTRY AND EGGS.

The following publications have been issued: Department Bulletin 391, "Accuracy in Commercial Grading of Opened Eggs;" Department Bulletin 702, "Efficiency of Commercial Egg Candling;" Department Bulletin 775, "Commercial Preservation of Eggs by Cold Storage;" and Department Circular 25, "Points for Egg Buyers."

A material diminution in the breakage of eggs during transportation resulting from faulty loading and stowing of freight cars was brought about through cooperation with the Railroad Administration. Employees of the Railroad Administration were detailed to the Bureau of Chemistry, where they received instruction in proper methods of loading and stowing eggs in freight cars. Whenever cars were received at terminals with the loads in a badly damaged condition, these employees of the Railroad Administration paid personal visits to the shipper for the purpose of instructing him how properly to load cars and avoid more damage in future shipments.

DAIRY PRODUCTS.

Much attention has been given to the development of analytical and microscopical methods for distinguishing from fresh milk remade milk, produced by combining mechanically skim-milk powder, water, and butter fat. No wholly satisfactory microscopic method has been devised. Physico-chemical methods have been found successful only under certain conditions. Physiological analytical methods have also been successful under some conditions, but it still remains to be determined whether any of these methods or any combination of them will prove universally applicable.

An extensive investigation designed to furnish information for use in the enforcement of the Food and Drugs Act has been undertaken

to develop methods for the detection of spoilage in cream and butter. The flora of the various types of old cream, the products of the action of microorganisms that may be present in such cream, the effect of neutralizing and pasteurizing it before churning, the production of butter from it, and the possible occurrence of the products of the metabolism of microorganisms in the butter are being studied. This investigation is conducted mainly in the field, in cooperation with the creameries. As such work can be done in a satisfactory manner only during a portion of the year, it is probable that it will be necessary to continue it through several seasons.

BEVERAGES.

An article entitled "Composition and Food Value of Bottled Soft Drinks" was published in the Department Yearbook for 1918.

The work begun last year upon the substitution of other sweetening agents for sugar as a means of sugar conservation was continued. Three articles on the subject, published in the trade journals during 1918, were widely copied. Three other articles were added this year, "Refiners' Sirup for Bottlers," "Soft Drinks without Sugar," and "Substitute Sirups for Soft Drinks." With the cooperation of the United States Food Administration, many thousands of copies of a brief résumé of the subject were distributed, and the information given in person at meetings of the trade. A valuable service was thus rendered the soft-drink industry, and many bottlers who were unable to secure sugar were saved from disaster. Some of the substitutes proved to have such merit that they probably will remain in permanent use.

Studies have been conducted upon soda flavors and upon the flora of sweetened nonalcoholic beverages. An article has been prepared upon the longevity of bacteria in commercial bottled water.

CITRUS BY-PRODUCTS.

The citrus by-product project was organized on its present basis in 1914, the object being to develop first upon a laboratory, and later upon a commercial scale methods for the manufacture of salable products from citrus fruit not suitable for shipment as fresh fruit. Minor defects, such as small bruises or punctures from thorns, gravel, or rough boxes, destroy the shipping value of fruit, as such defects offer points for infection to various bacterial and fungous growths which cause decay. Fruit that is too small or too large, unsightly or misshapen, has also a doubtful shipping value. The amount of waste fruit averages from year to year about 3 per cent of the total crop.

The by-product laboratory at Los Angeles has been studying the utilization of cull oranges in making stable products. Marmalade, marmalade stock, juice, vinegar, and candied peel are possibilities in this direction. Methods for the production of all of these, except juice, have been developed, and either have been given to the public or are now ready for publication. Candied peel and juice of excellent quality can be made from grapefruit, and methods for their production have been devised and given to the industry.

The existing methods for the manufacture of citrate of lime and citric acid have been improved and adapted to California conditions.

They are now being used satisfactorily on a large commercial scale, and while there will always be unsolved problems, as in every chemical industry, the methods of manufacture of citric acid are sufficiently well developed to permit its manufacture from the raw product at a fair profit to the lemon grower.

When these investigations were begun there were but one or two struggling by-product companies in California, which were making no appreciable inroad into the enormous supply of cull fruit available. After a few years' work and the expenditure of less than \$100,000 this situation has materially changed. Four stable, going concerns, three of them privately owned, and one a cooperative growers' company, are now manufacturing lemon by-products. The total annual manufacturing capacity of these plants is over 1,500,000 pounds of citric acid, over 500,000 pounds of citrate of lime, and over 50,000 pounds of lemon oil. Some 20 concerns may be said to be producing orange by-products on a considerable scale. The products consist largely of marmalade, about 50 per cent of which is produced by one cooperative company. Marmalade stock, jellies, and candied peel are also being made in smaller quantities. The total output of orange by-products for the present year will approximate 6,000,000 pounds. Proof of the advance which has been made since this project began is the increase in the price of cull fruit. Less than five years ago cull lemons could be had in large quantities at \$5 a ton; to-day advertisements appear in several agricultural papers offering from \$20 to \$25 a ton for the same material, in face of the fact that a larger quantity is now available. The same situation exists in the case of oranges. In former years \$5 would buy a ton of sound cull oranges; the price at the present time for sound culls is from \$20 to \$30 a ton.

The by-product laboratory has been in close touch with a great majority of the by-product manufacturers, advising them as to processes and assisting them in every possible way in establishing their business. No small amount of good has been accomplished in pointing out defects in proposed methods of operation, and much money and time has thus been saved investors and experimenters in this field.

Work upon the production of citrus by-products was also done in Florida during the year, and it is proposed next season to prosecute the Florida part of the project vigorously.

DEHYDRATION OF FRUITS AND VEGETABLES.

The special appropriation for dehydration did not become available till late in the fall, when the production of fruits and vegetables is small. The work that could be undertaken was therefore somewhat limited, and in consequence a considerable proportion of the funds available was not used. During the war a number of plants were constructed by private enterprise to dry fruits and vegetables for military purposes, but the majority of the products, while nutritious, were unattractive and inferior in quality. The bureau endeavored to investigate all the processes in use, in the hope of suggesting improvements whereby satisfactory dried fruits and vegetables might be produced, and a sound, permanent industry established. To this end all the larger plants were carefully inspected, and their processes studied under commercial conditions. Numerous conferences were held with

manufacturers, all of whom exhibited eagerness to cooperate and to offer every facility to promote the work. Laboratory investigations were undertaken to compare the nutritional qualities of dried products with those of canned and fresh material. About 30 departments of home economics, mostly in the agricultural colleges, cooperated, thus making it possible to reach conclusions more speedily than could have been done had the work been confined to a single laboratory. Studies on the nutritional value of dried products were also undertaken at Johns Hopkins University and at the University of Rochester. On the whole, the findings have been quite favorable.

Studies have also been made to determine the best conditions for the storage of dried products, especially the most suitable types of containers, and an investigation of the flora of such products is in progress. Bulletins bearing on the various phases of the dehydration work, now in preparation, should appear during the coming year. Two general addresses by those in charge of the work have been published, one of them as Office of the Secretary Circular 126, "Relation of Dehydration to Agriculture." The net result of the work has been of real practical assistance to the industry. Poor materials are disappearing from the market, and a few plants producing materials of excellent quality have become established.

In cooperation with a plant in South Carolina, an attempt was made by the bureau to produce sweet potato flour by the methods used with success in the production of white potato flour. The plant was operated for a few months, but the results were disappointing because of the very hygroscopic nature of the product which influenced unfavorably its keeping quality. The data will be published. The bureau has also been able to assist in the establishment of the white potato flour industry, which seems to be gaining ground. Data on potato flour and potato bread have been published.

Cooperation with the potato starch industry is in progress, looking toward the utilization of potato pomace, improvement of the methods for drying starch, the production of potato dextrin, and an increase in the capacity of the plants. Assistance was given to the Office of the Quartermaster General in the inspection and supervision of plants producing dehydrated vegetables for the Army.

FLOUR AND CEREALS.

Department Bulletin 701, "The Chemical Analysis of Wheat-Flour Substitutes and of the Breads Made Therefrom," has been issued, and a paper on the composition and baking value of the different sized particles of flour is in press.

As it was proposed during the year to import from Australia wheat badly infested with weevils, experiments were performed to determine the degree to which wheat may be heated in the attempt to destroy the weevils without affecting the quality of flour produced from the treated wheat. It was found safe to heat to 160° F., but not to 180° F., for 30 minutes.

Rice is one of the flour substitutes employed during the war which promises to continue to be used in baking. Baking experiments, therefore, were made with flour prepared from different varieties and grades of rice, polished to varying degrees. Fifteen per cent of rice and 85 per cent of white flour were used. No appreciable dif-

ferences were found in the baking qualities of such mixtures, irrespective of the fineness of the rice flour used. As was to be expected, the color of the bread was influenced by the degree to which the rice had been polished.

Much attention has been given to the study of the spoilage of corn meal, with a view to determining the most suitable conditions for its storage. The spoilage produced by different organisms and the effect of the growth of such organisms on the composition of the meal, especially with relation to acidity and rancidity, have been investigated, in the hope that a sound basis may be found to estimate the degree of spoilage of corn meal and its fitness for food.

GRAIN MILL, ELEVATOR, AND COTTON GIN EXPLOSIONS AND FIRES.

The emergency demonstration campaign, conducted in cooperation with the Bureau of Markets, to conserve grain and flour by preventing explosions and fires was carried out in the manner described in the Report of the Chemist for 1918. Five thousand six hundred plants were visited and over 30,000 pledge cards signed by the owners, operators, and employees. A number of recommendations suggested to the companies as possible precautions against dust explosions were cheerfully adopted, and it is believed that these slight changes have assisted in reducing the loss in this country due to explosions and fires in mills and elevators. Not a serious explosion occurred in such a plant during the year. A very disastrous explosion did occur in a different type of plant, a starch works, 43 persons being killed and a number injured. This demonstrates clearly that the work should be extended to other dusty industries. As no funds were available to proceed with the work after the close of the fiscal year, and as the U. S. Grain Corporation desired that it be continued as a form of insurance for its own operations, arrangements were made to transfer the force engaged upon this campaign to the rolls of the Grain Corporation. The work will be continued by that corporation, the Bureau of Chemistry collaborating by furnishing general supervision.

The campaign to prevent explosions and fires in thrashing machines has been continued and extended to cover other sections than Oregon, Idaho, and Washington, to which it had hitherto been limited. In cooperation with the Bureau of Plant Industry and the Bureau of Markets, special attention was given to the development of the suction-fan installation to remove dust from thrashing machines, and an effort was made to determine the effect of its operation on grain cleaning and on the possibility of smut-spore collection and disposal in order to prevent the dissemination of the spores over surrounding land. Plant pathologists have expressed themselves as quite hopeful that the devices for the disposal of spores which have been designed and tested may prove of great service in the control of the smut of wheat.

The discovery that many of the fires in the cotton gins of the Southwest are due to static electricity reported last year was confirmed this year. The limited funds available made it necessary to confine this work, which was done in cooperation with the Bureau of Markets and the various State and insurance agencies, almost en-

tirely to the State of Texas. Department Circular 28, "Cotton Gin Fires," issued during the year, was distributed among cotton ginners, insurance agencies, and others interested throughout the South. Though still unfinished, the work was closed at the end of the fiscal year, no appropriations being available thereafter.

DRUGS AND PHARMACOLOGY.

A series of researches upon crude drugs have been published under the following titles: "Commercial Viburnum Barks and Preparations;" "Karaya Gum, a Substitute for Tragacanth;" "*Ballota hirsuta* Benth., an Adulterant of Horehound (*Marrubium vulgare* L.);" "Piptostegia Root, *Piptostegia Pisonis* Mart, so-called Brazilian Jalap;" "Botanicals of the Blue Ridge;" "*Conium maculatum* L., and *Aethusa cynapium* L., an Adulterant;" and "So-called Syrian Alkanet, *Macrotomia cephalotes*, D. C." Manuscripts have been submitted for publication under the titles: "*Santolina chaemacyparissus* L., an Adulterant of *Matricaria chamomilla* L.;" "The Structure of Bermuda Grass Compared with that of Triticum;" and "Some Effects of the War upon Crude Drug Importations."

Evidence has been obtained that the part of ipecac which is often referred to as "stems" consists largely of the underground part of the axis, more properly referred to as rhizome. The young and smooth roots at times may also be considered as stem, since they resemble the rhizome rather closely in appearance. These parts, evidently referred to by mistake as stem, were found to contain appreciable quantities of ether-soluble alkaloids. It appears quite probable that the problem concerned with the utilization of this now rejected but valuable part of the ipecac plant can be solved by modifying the definition for ipecac to read: "The dried roots and rhizomes * * *."

The optical crystallographic properties of the cinchona alkaloids have been determined, so that a new method for their identification, even when present in small amounts if they can be obtained in crystalline form, is now available. An inquiry into the occurrence of lead in pharmaceutical zinc oxid has been published. A paper upon the preparation of sodium-p-hydroxyphenyl-arsenate, an intermediate in the manufacture of arsphenamine, and one entitled "A Review of the American Patent Literature on Arsphenamine (Salvarsan) and Other Arsenicals" have been issued.

A new method for determining the toxic effect of various agents administered over long periods of time in small dosage has proved of service. Young rats are placed upon such a standard, adequate diet as has been introduced by Osborne and Mendel and by McCollum. To the diet the substance under investigation is added, and the growth curve of the young animals plotted. Disturbances of health usually become evident when such growth curves are compared with those of normal animals. It is hoped that by this method it may be possible to determine the lower limit of toxicity of many substances. Such an investigation upon cadmium, which during the war it was proposed to substitute in part for tin in solder and other alloys, has been completed.

An extensive study on the toxic action of gossypol, a phenol found in cotton seed; to which the poisonous action of some cottonseed meal

has been attributed, is in progress. Complete information on this subject is necessary, in view of the recommendations now being made by various dietitians that cottonseed meal be used as food for man. The optical crystallographic properties of gossypol have been determined.

The description of a transparent celluloid renal oncometer or plethysmograph has been published.

The services of the bureau's experts were furnished the scientific division of the Shipping Board and the Tariff Commission, in connection with the consideration of drug and chemical products.

PLANT CHEMISTRY.

Seeds of about 40 individual plants of the mustards, *Brassica cernua* and *Brassica juncea*, grown in Illinois, have been examined separately for essential oil. In general, the volatile oil content of these seeds was much above the average, reaching in some cases 1.5 per cent. Seeds of the varieties from which the largest yields of oil were obtained have been planted at Arlington, Va., for further study. Under the title "Capsaicin, the Pungent Principle of Capsicum," the results of the study of the constitution of the pungent principle of red pepper have been published. It has been possible to produce synthetically a series of substances of marked pungency.

A report on the results of a survey on the caffeine content of the North American species of the genus *Ilex*, under the title "*Ilex vomitoria* as a Native Source of Caffeine," is in press. Of the various species examined, only *Ilex vomitoria*, used since prehistoric times by the Indians for the preparation of a beverage, was found to contain caffeine.

Department Bulletin 773, "Chemical Analyses of Logan Blackberry (Loganberry) Juices," has been issued.

To further the educational campaign to improve conditions in the production of tomato products, which has been conducted for some years, a paper on "Factory Investigations on the Manufacture of Tomato Pulp and Paste" was printed in a trade journal.

Articles upon the determination of the distribution of nitrogen in certain seeds, upon the reduction of nitrates by seedlings, and upon the effect of lime upon the alkali tolerance of wheat seedlings have been published. Studies of pumpkin and squash seed have been completed.

At the request of the Bureau of Plant Industry, the acidity of the soil under certain special conditions was investigated.

For the Bureau of Biological Survey many samples of water from North Dakota lakes were examined to obtain information regarding the propagation of aquatic plants.

In cooperation with the Bureau of Markets, an extensive survey is being made on the composition of cotton seed from various sections of the country. In addition to the analyses made in the bureau, 60,000 analyses have been obtained from 27 other laboratories, and arrangements to obtain from these laboratories similar analyses of the 1918 crop have been completed. Studies begun some years ago to determine whether the oil content of a given sample of seed could be estimated from the density of the seed, or the weight per thousand, and the like, factors of worth in the evaluation of barley, have not yielded results of value.

FOOD FLORA, SPOILAGE, AND FERMENTATION.

References to the year's work upon the spoilage and the flora of specific articles of food are made elsewhere in this report, where such foodstuffs are specifically considered. The general investigations upon poisoning by spoiled food have been continued, and some of the results embodied in two papers entitled, respectively, "Toxin Formation by a Variety of *B. botulinus* when Cultivated Aerobically under Various Conditions: Its Possible Production in the Animal Body," and "Botulism from Canned Asparagus." In general, the results indicate that the strain of *Bacillus botulinus* isolated from the spoiled asparagus which produced fatal poisoning is capable of withstanding the temperature used in the processing of canned goods by methods in vogue for home canning or for commercial canning, that the organism produces putrefactive decomposition, and that the principal safeguard against poisoning from such types of organisms as this lies in the scrupulous examination of every can of material to make sure that no spoiled food is included in the portions eaten.

The study of the molds used in the oriental fermentation industries has included several lines of experimentation. Soy sauce has been made according to the methods employed in Japan. Enzymic studies have been performed with a bran koji made with *Aspergillus Wentii* and various strains of *Aspergillus flavus*. The metabolism of this group of organisms has been studied, especially the chemical changes they produce in soy fermentation, and the formation of phenolic substances. A study of Chinese red rice as produced by the growth of *Monascus purpureus* has been prepared for publication under the title of "Laboratory Experiments on the Manufacture of Chinese Ang-khak in the United States."

In connection with the studies to improve the manufacture of pickles and prevent the losses that occur at present because of the softening of the pickles during storage, arrangements have been made with the Bureau of Plant Industry and with the Mississippi Agricultural College to study the fermentable sugar content of different varieties of cucumbers. Cooperation has also been maintained with manufacturers of sauerkraut, with a view to controlling the temperature of the kraut as it goes into the fermenting vat, in order to obtain more nearly the optimum conditions of fermentation than has hitherto been the case. A report on the use of pure culture starters in the preparation of sauerkraut has been issued. The work on the preservation of foods by fermentation and brining has been continued, and the information of value thus obtained has been transmitted to the States Relations Service for demonstration in the field. A report of the work is in manuscript form. A paper entitled "A Preliminary Report upon Some Halophilic Bacteria" has been printed.

The requests for cultures from the bureau's extensive and growing collection have been numerous, centering, in recent years, upon the citric-acid-forming group of molds, the cheese-ripening fungi, and those connected with the oriental fermentation industries. Many routine identifications of cultures were made for various investigators.

A communication was made upon the chemical analyses of bacteriological bouillons.

INSECTICIDES AND FUNGICIDES.

Department Bulletin 750, "A Method for Preparing a Commercial Grade of Calcium Arsenate," and a communication on plants used as insecticides, have been printed, while a paper describing the diagnostic characters of the field daisy, used as an adulterant of pyrethrum, is in press. Equipment to produce insecticides and fungicides on a semicommercial scale has been secured, to the end that ways and means to improve manufacturing processes and to devise new types of useful insecticides and fungicides may be investigated. In cooperation with the Bureau of Entomology, the possible value of war gases as insecticides has been taken up. Phosgen and cyanogen chlorid have been studied. The field men of the Bureau of Entomology have been assisted in the work of controlling the boll weevil.

CONTAINERS.

The bureau was invited to designate a representative to serve upon the Committee on Standard Specifications for Kitchen Ware, Mess Equipment, and Flat Ware for the Army. This led to the examination of 61 samples of enamel ware from 26 different American manufacturers. The test most frequently used was made by boiling 500 cubic centimeters of 4 per cent acetic acid, the strength of standard vinegar, in the vessel for half an hour. No antimony was dissolved from 17 samples obtained from 9 manufacturers. Thirty-four vessels, both white and gray ware, yielded to the solution from 0.5 to 2.0 milligrams of antimony. Lead was found in ware from only one manufacturer. Earthenware was then examined, and in some instances its glaze was found to yield to the acetic acid solution small amounts of lead.

Analyses have been made for the War Department and the War Industries Board of foil used to wrap food products and other materials. Some foil is pure aluminum, some is pure tin, while some contains lead and tin, with the tin varying from 1 to 30 per cent. Some of the composite foils appear to be alloys, while others consist of an inner layer of lead covered by two layers of tin. In most of the instances when foil containing lead is used a waxed paper wrapping is placed between the metal and the food product.

Except in the case of phosphorus matches, there are no Federal laws to protect the public against the presence of poisonous substances in articles of common use in the household. Many foreign countries have long had such legislation on their statute books.

Cooperation with the industry to ascertain what types of tin plate are most suitable for food containers has been continued. Special attention is being given to the best means of preventing the perforation of cans containing acid fruits. The results of the successful trial in a tin mill under ordinary conditions of hydrogenated oils in place of palm oil have been prepared for publication.

A paper dealing with the use of the impact tester for fiber board has been presented, and work was continued on the improvement of the water-resisting properties of fiber board for fiber containers, both by substituting other adhesives for silicate of soda and by using external treatments which will not interfere with the future use of the stock. A report on the various kinds of water-resistant baling papers was given.

COLOR INVESTIGATIONS.

The general plan of the color investigations which have been in progress in the bureau for but a few years was first fully discussed in the Report of the Chemist last year. This year it is possible to report specific results.

Work upon photosensitizing dyes was begun at the instigation of the War Department. The three important sensitizing dyes, pinacyanol, pinaverdol, and dicyanin, have been prepared and made available. Preparations of these dyes have been distributed to those requiring them, including photographic plate manufacturers and astrophysicists, who have reported them satisfactory. A new dye showing absorption further in the infra-red part of the spectrum than any other known dye has been prepared. It may prove of great value to physicists. New processes for the manufacture of these photosensitizing dyes have been discovered and patent applications filed. Four papers upon the chemical properties of and the methods for producing these dyes and their intermediates and one upon their crystallographic and optical constants have been published. As it is now possible to establish in the United States this very small but scientifically extremely important branch of the dye industry, steps to bring this about are being taken.

The new method developed in the bureau for the production of phthalic anhydrid by catalytic air oxidation is in successful commercial use, and cooperation was begun with another manufacturer during the year. Certain theoretical laboratory investigations remain to be completed before a final report of the whole investigation can be published.

From cymene a new photographic developer has been produced and the process published. Studies upon the chlorination of cymene are in progress. A report upon the preparation of 2-chlor-5-6-dinitrocymene is ready for the printer.

The sulphonation studies have progressed to such a point that cooperation with the industry upon the sulphonation of benzene has begun. Observations of great interest, especially on the sulphonation of naphthalene, are in process of investigation. Reports have been prepared upon "Some Difficultly Soluble Salts of Certain Naphthalene Sulphonic Acids," and upon "A Method for the Qualitative Determination of Some of the Naphthalene Sulphonic Acids."

The laboratory and plant studies on the production of isopropyl alcohol and its oxidation to acetone, undertaken for the Bureau of Aircraft Production, have been completed. It seems probable that the process will prove of commercial value.

Papers have also been presented upon the following subjects: "Some Aspects of the Behavior of Charcoal with Respect to Chlorin;" "A Method for the Purification of Certain Azo Dyes;" and "The Catalysis of Some Vapor Phase Oxidation Reactions."

The laboratory under construction at Arlington for large-scale or semi-industrial operations, which was loaned to the Nitrate Division of the Bureau of Ordnance during the war, has been released to the Bureau of Chemistry and should be ready for occupancy during the coming year.

LEATHER AND TANNING.

Farmers' Bulletin 1055, "Country Hides and Skins," has been prepared in cooperation with the Bureau of Animal Industry and Bureau of Markets. Plans have been made to disseminate the information contained in this bulletin widely through the county agents of the States Relations Service, the distribution of posters, and the like, in the hope that the very great waste of valuable raw materials that now occurs because of lack of knowledge may be stopped. Papers on the waterproofing of leather, on the relative absorption of oils and greases by wet and dry leather, on the testing of materials for increasing water resistance of sole leather, and on the suitability of various solvents for the extraction of oils and greases from leather were presented at various meetings of technical societies. A farmers' bulletin on the care of shoes and harness is in preparation. Assistance has been rendered the War Department and the War Industries Board in regard to the waterproofing of leather and the preparation of specifications for various kinds of leather, the Post Office Department on specifications for bag leather, and the U. S. Shipping Board. Methods for the tanning of alligator skins have been furnished the Indian Commission of the Interior Department, which contemplates the establishment of the industry among the Indians of Florida.

NAVAL STORES.

The final report on the production of naval stores, including gum rosin and gum turpentine, wood rosin and wood turpentine, and rosin reclaimed from batting dross, has been published, and put into the hands of producers, factors, dealers, and consumers of naval stores. This report shows the total production for the last season, stocks on hand at stills on March 1, 1919, and total shipments from stills during the period from April 1, 1918, to March 1, 1919. Reports have also been made of the stocks of rosin and turpentine in the hands of the consumers of naval stores and of the stocks in the storage yards at the principal points of distribution in the country. Assistance was given the Bureau of the Census in the preparation of the schedule for naval-stores statistics and of the lists of naval-stores producers.

Specifications on the properties, the sampling, and the laboratory examination of turpentine have been prepared and submitted to the Interdepartmental Committee on Paint Specifications for Government Bureaus. Much investigational work was required in this connection, because fresh virgin turpentine may not reach the minimum limits formerly set for specific gravity and refractive index, while turpentine taken from storage tanks in the South which have remained partly filled for a year or more may exceed the limits previously set for these constants.

In accordance with the practice of the past to place glass types for grading rosin at convenient points, a set of types has been deposited on loan with the secretary of the Chamber of Commerce of Cleveland, Ohio, for the use of consumers and dealers in that vicinity.

PAPER AND FABRICS.

Assistance in the preparation of specifications for paper has been given to the congressional Joint Committee on Printing, to the Post Office Department, and to the Treasury Department.

The study of the waterproofing, mildewproofing, and fireproofing of fabrics for farm use has been continued. A farmers' bulletin on waterproofing and mildewproofing for farm purposes, as well as an article on the general toxicity of soaps of heavy metals, alone and in combination, to fungi occurring on textiles, are in preparation. A paper entitled "Water Resistance of Fabrics" is in press.

Assistance has been given to the Office of the Quartermaster General and to the Chief of Staff of the Army on the preservative treatment of fabrics and on the repairing and waterproofing of tentage.

METHODS AND APPARATUS.

Methods have been published for the estimation of theobromin, of potassium guaiacol sulphonate, of citral, of mercury precipitated as mercuric zinc thiocyanate, of zinc precipitated as zinc mercury thiocyanate, of copper in insecticides, of zinc and copper in gelatin, of tyrosine in proteins, of the loosely bound nitrogen in eggs as ammonia, of the lower alkylamines in the presence of ammonia, of coumarin in factitious vanilla extracts, of iodine in mineral waters and brine, and of the acidity of grain extracts. Report has been made upon the use of benzaldehyde sulphite compound as a standard in the quantitative separation and estimation of benzaldehyde and benzoic acid, upon a method for the rapid analysis of mixtures of chlorinated toluene, and upon the use of thymosulphophthalein as an indicator in acidimetric titrations.

Methods are in process of publication upon the determination of bromide in mineral waters and brines, the estimation of monobromated camphor in migraine tablets, the use of kaolin in tannin analysis, the determination of water solubles in leather, the determination of caffeine, and the determination of the water resistance of fabrics. Certain other investigations upon analytical methods are referred to elsewhere in this report.

Descriptions of laboratory apparatus for rapid evaporation, and of a new type of volumometer have been published.

The bureau's machinery for the examination of supplies purchased has been reorganized, and a paper on the general subject of laboratory apparatus was presented to the American Chemical Society.

ANALYTICAL WORK FOR OTHER DEPARTMENTS.

For other executive departments and Government establishments, 17,392 samples were analyzed. This is a larger number than normal, due to the fact that the various war agencies called upon the bureau for much analytical work in the purchase of war materials, particularly food, drugs, and leather. While it is not probable that the number of samples analyzed for other departments and war agencies will be as large in subsequent years, the indications are that it will be noticeably larger than before the war, since many of the Government agencies have found that a chemical test of materials purchased

aided them in determining and controlling the quality of such materials, and they will avail themselves of this service in time of peace as well as in time of war.

In addition to the samples analyzed for the various departments, as shown in Table 3, the bureau conducted extensive investigational work on a number of problems for the various governmental agencies.

TABLE 3.—*Samples analyzed for other departments.*

Department.	Number of samples	Department.	Number of samples.
Department of State.....	4	District of Columbia.....	14
Department of the Treasury.....	319	Council of National Defense.....	25
Department of War.....	9,310	Shipping Board.....	7
Department of Justice.....	411	Smithsonian Institution.....	1
Post Office Department.....	96	General Supply Committee.....	5
Department of the Navy.....	1,184	Allied purchasing boards.....	8,993
Department of the Interior.....	26	War Trade Board.....	10
Department of Commerce.....	193	Emergency Fleet Corporation.....	2
Food Administration.....	161		
Government Printing Office.....	1	Total.....	20,563
The Panama Canal.....	106		

REPORT OF THE CHIEF OF THE BUREAU OF SOILS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., September 18, 1919.

SIR: I have the honor to transmit herewith a report covering the operations of the Bureau of Soils for the fiscal year ended June 30, 1919.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

SOIL SURVEY.

The war did not make itself felt in a decrease of the work done by the Soil Survey before the spring of 1918. With no increase in the field staff the area covered in 1918 was greater than the year before. In 1919 the effect of the war was shown in a decreased area covered, which was a little more than 4,000 square miles less than the area covered in 1918. During the closing months of the fiscal year 1918 many members of the field staff entered the military service, reducing the effective force to about two-thirds its normal strength, at which point it was with difficulty maintained during the greater part of 1919.

Detail surveys were made during the year in 27 States. In 22 of these the work was done in active cooperation with State organizations. The area covered in these States amounted to 27,456 square miles. In five States 4,532 square miles of noncooperative work was done, the percentage of such work being slightly higher during 1919 than 1918. The total area surveyed in detail during the year was 33,988 square miles.

Reconnaissance soil mapping was confined during the year to one area in the High Plains section of western Texas. This area comprised territory of an extent of 6,085 square miles.

The total area covered by detailed surveys in continental United States up to June 30, 1919, amounted to 517,940 square miles.

The following tables give in detail statistics covering the operations for the last year and also a summary statement of the area surveyed from the beginning of the work in 1899 to date.

Notwithstanding the fact that the work of the Soil Survey is not directly concerned with production and that no funds were received from the emergency appropriation, a certain amount of work bearing on the prosecution of the war was done at the request of the War Department in connection with the constructing of the progressive military map of the United States. In large areas of the Coastal Plain section of the United States the base maps prepared by the Soil Survey were the most reliable maps in existence. All of the published maps of this region were used by the War Department and the base-map information contained in unpublished soil maps was compiled and turned over to the Corps of Engineers. In ad-

dition to this the areas for survey in Southern States during the winter of 1918-19 were selected, at the request of the War Department, in localities where there was greatest need of fundamental information. Placing the areas according to this plan was done in every case with the consent of the cooperating State concerned.

Individual areas surveyed and mapped during the fiscal year ended June 30, 1919.

DETAILED.

State.	Area.	Area surveyed.	
		Square miles.	Acres.
Alabama.....	Geneva County.....	257	164,480
	Houston County.....	445	284,800
	Marengo County.....	¹ 270	172,800
California.....	Brawley Area.....	315	201,600
	Grass Valley Area.....	¹² 114	72,960
	Shasta Valley.....	220	140,800
Delaware.....	Kent County.....	¹ 177	113,280
	Sussex County.....	416	266,240
Florida.....	Duval County.....	391	250,240
	Orange County.....	¹ 605	387,200
Georgia.....	Butts-Henry Counties.....	527	337,280
	Coweta-Fayette Counties.....	704	450,560
	Green - Morgan - Putnam - Oconee Counties.....	1,346	861,440
	Madison County.....	286	183,040
Idaho.....	Bannock County.....	3,179	2,034,560
Iowa.....	Payette County.....	164	104,960
	Louisa County.....	396	253,440
	Madison County.....	563	360,320
	Mahaska County.....	128	81,920
	Marshall County.....	573	366,720
	Palo Alto County.....	561	359,040
	Polk County.....	582	372,480
	Wayne County.....	¹ 358	248,320
	Winnebago County.....	¹ 296	189,440
	Wright County.....	106	67,840
Kentucky.....	Logan County.....	¹ 123	78,720
	Muhlenberg County.....	168	107,520
Louisiana.....	Sabine Parish.....	¹ 631	403,840
Maryland.....	Carroll County.....	390	249,600
	Charles County.....	464	296,960
Massachusetts.....	Bristol County.....	165	105,600
Mississippi.....	Choctaw County.....	¹ 124	79,360
	Lamar County.....	¹ 252	161,280
	Simpson County.....	575	368,000
	Smith County.....	369	236,160
Missouri.....	Chariton County.....	768	491,520
	Polk County.....	149	95,360
	Reynolds County.....	578	369,920
	St. Louis County.....	116	74,240
Nebraska.....	Banner County.....	240	153,600
	Cheyenne County.....	¹ 992	634,880
	Red Willow County.....	155	99,200
	Sheridan County.....	¹² 2,067	1,322,880
	Sioux County.....	120	76,800
New Jersey.....	Bernardsville Area.....	522	334,080
	Chatsworth Area.....	¹⁸ 682	436,480
New York.....	Chenango County.....	¹ 664	424,960
	Wayne County.....	123	78,720
	White Plains Area.....	864	552,960
North Carolina.....	Moore County.....	639	408,960
	Vance County.....	279	178,560
	Wilkes County.....	¹² 73	174,720
North Dakota.....	Traill County.....	865	553,600
Oregon.....	Josephine County.....	210	134,400
	Multnomah County.....	160	102,400
	Washington County.....	731	467,840
Pennsylvania.....	Lycoming County.....	¹ 36	23,040
South Carolina.....	Greenville County.....	364	232,960
	Kershaw County.....	673	430,720
	Spartanburg County.....	285	182,400
Tennessee.....	Meigs County.....	⁴ 200	126,000

¹ These figures do not include portions of these areas surveyed in preceding years.

² Area enlarged by 114 square miles.

³ Reported as Toms River Area in 1918 report.

⁴ 70 square miles surveyed in July, all included in fiscal year.

Individual areas surveyed and mapped during the fiscal year ended June 30, 1919—Continued.

State.	Area.	Area surveyed	
		Square miles.	Acres
Texas.....	Dallas County.....	334	213,760
	Denton County.....	1 267	170,880
	Erath County.....	356	227,840
	Freestone County.....	1 350	224,000
	Tarrant County.....	456	291,840
Virginia.....	Pittsylvania County.....	1 611	391,040
Washington.....	Wenatchee Area.....	600	384,000
West Virginia.....	Braxton and Clay Counties.....	849	543,360
	Webster County.....	1 321	205,440
Wisconsin.....	Jackson County.....	1 328	209,920
	Kenosha County.....	274	175,360
	Outagamie County.....	1 105	67,200
	Walworth County.....	112	71,680
Total.....		33,988	21,752,320

¹ These figures do not include portions of these areas surveyed in preceding years.

RECONNOISSANCE.

Texas.....	Northwestern Reconnaissance.....	6,085	3,894,400
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Areas surveyed and mapped in the several States during the fiscal year ended June 30, 1919, and the areas previously reported.

DETAILED.

State or Territory.	Work dur- ing 1919 (square miles).	Work pre- viously reported (square miles).	Total.	
			Square miles.	Acres.
Alabama.....	972	45,631	46,603	29,825,920
Arizona.....		961	961	615,040
Arkansas.....		11,934	11,934	7,637,760
California.....	649	19,229	19,878	12,721,920
Colorado.....		2,809	2,809	1,797,760
Connecticut.....		1,704	1,704	1,090,560
Delaware.....	593	1,186	1,779	1,138,560
Florida.....	996	10,815	11,811	7,559,040
Georgia.....	2,863	22,199	25,062	16,039,680
Idaho.....	3,179	3,109	6,288	4,024,320
Illinois.....		6,770	6,770	4,332,800
Indiana.....		11,062	11,062	7,079,680
Iowa.....	3,757	13,185	16,942	10,842,880
Kansas.....		9,016	9,016	5,770,240
Kentucky.....	291	3,898	4,189	2,680,960
Louisiana.....	631	13,022	13,653	8,737,920
Maine.....		2,197	2,197	1,406,080
Maryland.....	854	5,934	6,788	4,344,320
Massachusetts.....	165	1,494	1,659	1,061,760
Michigan.....		5,708	5,708	3,653,120
Minnesota.....		5,301	5,301	3,392,640
Mississippi.....	1,320	23,142	24,462	15,655,680
Missouri.....	1,611	29,794	31,405	20,099,200
Montana.....		882	882	564,180
Nebraska.....	3,574	18,660	22,234	14,229,760
Nevada.....		235	235	150,400
New Hampshire.....		1,411	1,411	903,040
New Jersey.....	1,204	5,195	6,399	4,095,360
New Mexico.....		596	596	381,440
New York.....	1,651	17,771	19,422	12,430,080
North Carolina.....	1,191	28,244	29,435	18,838,400
North Dakota.....	865	12,362	13,227	8,465,280
Ohio.....		10,102	10,102	6,465,280
Oklahoma.....		6,540	6,540	4,185,600
Oregon.....	1,101	2,679	3,780	2,419,200
Pennsylvania.....	36	15,129	15,165	9,705,600
Porto Rico.....		330	330	211,200
Rhode Island.....		1,085	1,085	694,400

Areas surveyed and mapped in the several States during the fiscal year ended June 30, 1919, and the areas previously reported—Continued.

State or Territory.	Work during 1919 (square miles).	Work previously reported (square miles).	Total.	
			Square miles.	Acres.
South Carolina.....	1,322	20,558	21,880	14,003,200
South Dakota.....		675	675	432,000
Tennessee.....	200	8,725	8,925	5,712,000
Texas.....	1,763	29,194	30,957	19,812,480
Utah.....		1,951	1,951	1,248,640
Vermont.....		1,175	1,175	752,000
Virginia.....	611	9,102	9,713	6,215,320
Washington.....	600	10,152	10,752	6,881,280
West Virginia.....	1,170	14,845	16,015	10,249,600
Wisconsin.....	819	15,408	16,227	10,385,280
Wyoming.....		855	855	547,200
Total.....	33,988	483,961	517,949	331,487,360

RECONNOISSANCE.

Alaska.....		31,768	31,768	20,331,520
Arkansas-Missouri.....		58,000	58,000	37,120,000
California.....		32,135	32,135	20,565,400
Kansas.....		39,960	39,960	25,574,400
Nebraska.....		53,064	53,064	33,960,960
North Dakota.....		39,240	39,240	25,113,600
Ohio.....		41,420	41,420	26,508,800
Pennsylvania.....		41,405	41,405	26,499,200
South Dakota.....		41,400	41,400	26,496,000
Texas.....	6,085	92,297	98,382	62,964,480
Washington.....		13,115	13,115	8,393,600
Wisconsin.....		14,425	14,425	9,232,000
Total.....	6,085	498,229	504,314	322,760,960

Cooperative work with the Forest Service was carried on during the year in certain studies in Utah, Arizona, and in a number of Southeastern States. In the latter the work had especial reference to the relation of soil character to kind and character of forest growth. Information of this kind was desired in certain reforestation studies in the area of cut-over lands in the South. The work in Utah and Arizona also was concerned primarily with the relation of the soil to the growing of forest trees.

The study of the soil conditions on the public lands, in cooperation with officials of the Geological Survey engaged in land-classification work, was continued through August, 1918, when the party assigned to this work was called for by the Reclamation Service. This work with the Geological Survey was concerned primarily with the problems of soil classification in the Great Plains States, and a great deal of valuable information concerning the soils in the region was obtained. The data will be useful in preparing a soil map of the United States upon which the bureau and the Office of Farm Management are engaged. Studies of the same character, independent of the Geological Survey, were made in southeastern Utah and southwestern Colorado, late in the season after the forest-survey work in Utah had been finished.

At the request of the Reclamation Service, Interior Department, a party was assigned to the work of examining the soils of a number of areas in Wyoming, Utah, and Arizona, with regard to the feasi-

bility of extending a number of existing irrigation projects. This work was carried on from the middle of August until midwinter.

The bureau also assisted the Bureau of Entomology of this department in the examination of the soils of several areas in the grape-growing sections of California, where the vineyards were suffering from phylloxera.

At the request of the American Geographical Society, in whose charge was placed the work of the House Commission for the Accumulation of Geographic and Economic Information concerning undeveloped or imperfectly developed parts of the world, information relating to the soils of Africa and Asiatic Russia was compiled. A generalized soil map of Africa, based on existing literature, was prepared and transmitted to the State Department.

At the request of the State Department, a party from the Soil Survey was sent in the spring of 1919 to Central America for the purpose of making an economic survey of parts of Guatemala and Honduras. The party finished its field work and returned to Washington in June. At the close of the year considerable progress had been made in the preparation of a report covering the work done. An area of about 12,000 square miles was examined.

The African compilation and the studies made in Central America not only supplied the information desired by the institutions requesting it, but also gave results of much value to the Soil Survey.

An exhibit of the work of the Soil Survey was prepared during the early part of the fiscal year, and during September and October a man from the division, accompanied by representatives of certain other bureaus of the department, visited a number of State fairs for the purpose of presenting and explaining the work of the bureau. During the latter part of the winter a more elaborate exhibit was prepared. This was sent abroad for use in the field schools of agriculture maintained in France for the benefit of American soldiers.

Much advice and information by correspondence was given during the year. This work was heavier than usual, owing to the country-wide interest in war gardens, and involved the examination of a large number of samples of soil.

The work of studying the truck soils of the eastern United States continued during the year, with some interruptions caused by emergency calls to other work, such as the preparation of the exhibits for the fair circuits and for the American soldiers in France. The field work in the Charleston area was completed and the report prepared for publication.

At the suggestion of the Railroad Administration the preparation of a series of reports on the soils of certain of the Southern States was begun, and on June 30 considerable progress had been made on the initial report of the series.

CHEMICAL INVESTIGATIONS.

During the fiscal year 1919 miscellaneous samples from other departments, other bureaus of this department, outside institutions, and private individuals have been analyzed or examined as usual. These have included the alkali analyses of soils for the Geological Survey and the Bureau of Standards, the examination of park soils for the District government, cooperative tests of soils from the Arlington

Farm for the Bureau of Plant Industry, and the examination of numerous samples of rocks, minerals, soils, etc., supposed to be of value as fertilizer.

During the earlier part of the year research work on the composition of soil types was continued, but later this was abandoned on account of the rush of war activities. After the signing of the armistice work was resumed upon this subject. The major research activities of the Chemical Division, however, have centered about the chemical and mineralogical nature of the materials extracted from soils by treatment with water. A number of minerals have been identified in these products and it has been shown that the evaporated water extract of soils leaves a residue showing considerable resemblance to the Stassfurt and other natural saline deposits. A material, provisionally called ultra clay, has also been obtained by these extractions and its properties are now being investigated. These lines of work, together with the study of the chemistry of the soil solution, now well under way, are in certain respects unique and give promise of important results.

The war activities consisted mainly of the analysis of numerous samples of zircon sands in cooperation with the Bureau of Mines, the Geological Survey, and the Bureau of Standards. For some time this work absorbed the whole attention of the division. The other direct war activity consisted of the determination of the lime requirement and the preparation of various special soils for the Chemical Warfare Section.

The head of the division, Dr. E. C. Shorey, resigned and a new head was not appointed until the close of the year. During the greater part of the year a large part of the personnel of the division was detailed to the Fertilizer Division for war work on nitrogen products.

FERTILIZER RESOURCES INVESTIGATIONS.

FERTILIZER CONTROL.

During the fiscal year 1919 the Division of Fertilizer Resources Investigations worked in cooperation with a number of other governmental agencies on problems directly or indirectly connected with fertilizers. Until the signing of the armistice the division assisted the Office of Fertilizer Control, furnishing technical information regarding fertilizers, their sources, supply, and manufacture, and advising on many problems arising in Government control. With the cessation of active hostilities and the disbanding of the emergency organization certain phases of the work upon which the Office of Fertilizer Control had been engaged were placed in charge of the Bureau of Soils and became a part of the duties of this division.

In response to complaints of farmers of the high cost of fertilizers, an investigation was made of retail prices in the Southern and Eastern States, where practically all the fertilizer used in this country is consumed. In gathering these data the bureau was assisted by the States Relations Service, working through its county agent organization. The results, published in circulars of the department series and appertaining to conditions in the months of May and June, 1919, showed not only excessively high prices in many parts of the country,

but also striking inconsistencies between the quotations of dealers in adjacent counties and even in different parts of the same county, the disparity being much greater than could be explained away on the ground of differences in freight rates.

It is believed that the publication of the information has tended to equalize prices, or at least has put the farmer on his guard and shown him that he can save much in the cost of fertilizer by judicious purchasing.

Studies of the fertilizer trade also have been concerned with existing methods of computing the cost of manufacture, of establishing wholesale prices, and of providing for distribution.

NITROGEN INVESTIGATIONS.

Work has been continued on the fixation of atmospheric nitrogen in cooperation with the Bureau of Ordnance, Nitrate Division, of the War Department. This has involved three lines of investigation: (1) The synthetic, or so-called Haber process for the formation of ammonia from hydrogen and nitrogen; (2) the preparation and use of cyanamid for fertilizer purposes; and (3) the utilization of the silent discharge at high potential for the production of nitric acid. The first of these investigations had advanced to such a stage that we were able soon after war was declared to be of considerable service to the War Department in investigating their special problems, the Arlington laboratory being put at their disposal for such purposes. In the year just closed work along all of the lines mentioned has been extended. At the invitation of the Fixed Nitrogen Research Laboratory, the men engaged in these investigations have been moved to the American University to continue the work in cooperation with the War Department.

PHOSPHATES.

Investigation of a method for the manufacture of phosphoric acid by smelting the rock and recovering the acid from its gaseous state has continued during the year. In the last report mention was made of the results achieved with a specially designed furnace of small size. This contrivance, itself the result of much experimental work, is operated with fuel oil, and possesses the advantage over the electric furnace first tried of being much cheaper to run. Experiments with the new type of furnace are being carried out on a larger scale to determine its commercial value. If the feasibility of this method can be shown, its ultimate general adoption by the producers of acid phosphate would seem assured, for the advantages—elimination of waste in mining, production of a pure acid, and saving in the cost of hauling an immense tonnage of inert material—are manifestly too great to be ignored by those engaged in the business of phosphate manufacture.

POTASH.

Investigations of the potash resources of the country have been continued principally in connection with the recovery of the salt from flue dust and its production from kelp. Many samples of the dust from blast-furnace stacks and some additional samples from

cement plants have been collected and analyzed, and the bureau sees in this field the opportunity to produce much of the potash needed in the agriculture of the country. Work is being done on the availability of the potash found in blast furnace and cement-plant flue dust.

During the fiscal year ended June 30, 1918, the kelp plant at Summerland, Calif., in charge of Dr. J. W. Turrentine, was in partial operation. The close of that year found this organization approaching the end of its first year of operation. It was struggling with many problems and difficulties, some of inherent origin and some resulting from the national condition of a state of war. In spite of these, however, the experiments and the investigations were being actively prosecuted with a view to the determination of by-products, the elaboration of processes for their recovery, the perfecting of processes already installed, and the establishment of complete cost and efficiency data regarding all features. These problems were under full development. Organization and production had been brought to a point where over considerable periods operating expenses were approximately equaled by proceeds from sale of the products dry kelp and kelp ash.

At the beginning of the new year, the problem demanding most immediate solution was that of the large-scale leaching of kelp char. This had to be done mechanically and by a nonintermittent process. Processes devised by other concerns were either entire failures or cumbrous and highly inefficient. Following plans drawn up in this office and data established by experimentation here, a lixiviator was constructed and installed and put into operation which represented the immediate and complete solution of this problem.

Following this, the evaporator equipment, already tested by intermittent operation, was put into steady use, and high-grade potash salts became a daily product. Centrifugal and rotary, counter-current, hot-air dryers were installed to reduce the potash salts to the desired moisture content, and a material of high potash content and of a satisfactory physical condition was thus established as a daily product.

As in every other operation, a considerable period of time was consumed in training our operating crew in the details of producing potash salts and in studying the best method of operation of the apparatus installed. Although the evaporator and crystallizer have been in successful operation for half a year, the refinements of operation yielding potassium chloride of the highest degree of purity have not yet been introduced. This being a matter of no immediate urgency, it has been permitted to await a more favorable opportunity.

As a part of the problem of determining the various factors that influence iodine with respect to its concentration and condition in the various stages of its course from the wet, raw kelp to the mother liquor from which iodine is precipitated, Prof. Merle Randall, of the Department of Chemistry of the University of California, is making a complete study of the composition of solutions; and, on the basis of the results to be obtained, it should be possible easily to introduce those modifications in process which will result in a grade of product so high as to commend itself to the chemical trade and demand a cor-

respondingly high price. No source of potash is known to us which lends itself so readily to the preparation of a chemical grade of potash as does kelp. Every consideration demands that the highest grade of potash practicable be striven for.

A year ago it had just been established that the charcoal yielded as a by-product by the lixiviator and remaining after the potash and iodine had been removed possessed potentially high value as a bleaching carbon or agent for removing coloring matter from a variety of organic liquids and solutions not susceptible of bleaching chemically. This was shown to be potentially as valuable as a material formerly imported from Europe and selling at a price of 20 cents per pound. Recognizing the possibilities which lay in such a by-product, every effort was made both to determine definitely its bleaching power when applied to various classes of products and the best method of its manufacture in satisfactory and uniform condition. Neither problem is yet completely solved, as tests are still being made here and also collaboratively by various commercial concerns, both on laboratory and plant scale, and the ideal method of manufacture has not yet been devised. However, the matter has progressed to the point where sales have been effected at 15 cents per pound and production brought to the point where this product appears about to be able to pay the production cost of itself and of the potash also, if not ultimately the operating cost of the entire enterprise.

Certainly kelp char and potash combined should enable us to pay all expenses and probably yield a profit.

It is definitely established that the process in its present stage of development will yield iodine of a daily value of \$50 to \$75. It is entirely probable that a nearer approach to the theoretical will be attained.

A further development of the crystallization method employed should yield common salt of a degree of purity to warrant its sale as such in the local market in quantity sufficient to represent a considerable daily revenue and net profit.

It is now definitely established by large-scale operations over a period of months that the destructive distillation of kelp yields ammonia in that form which makes possible commercial recovery. Experiments to date indicate no considerable loss of the nitrogen of kelp in other forms. This fact, coupled with that of the simultaneous production of combustible gas of a quality and quantity sufficient greatly to reduce if not to eliminate fuel consumption (the main item of expense), in connection with the distillation, and of kelp tar, whose subproducts, kelp oils and creosote, have been shown to be of value as flotation agents and disinfectants, respectively, not only justifies that process, but furthermore indicates the certainty wherewith these products may be looked to ultimately to pay the operating expenses of that process and to yield a profit besides.

A prospectus based on results as they stood June 30, 1919, is inserted here as illustrating what is now expected as the results shortly to be attained as the outcome of the present stage of these experiments. The conservativeness of the estimates should counterbalance the prophetic nature of the statement.

PROSPECTUS OF VALUE OF PRODUCTS OBTAINABLE FROM 100 TONS PER DAY
RAW KELP.

Potassium chloride, 95 per cent:	
2.5 tons=150 units at \$2-----	\$300
Or 150 units at \$2.50-----	\$375
or 2.5 tons chemical grade at \$250 per ton-----	625
Salt, NaCl, 95 per cent:	
1 ton at \$25-----	25
Iodine, resublimed:	
20 pounds at \$4-----	80
Ammonia, ammonium sulphate, 95 per cent:	
400 pounds NH_3 or 1,600 pounds $(\text{NH}_4)_2\text{SO}_4$ at \$4 per hundredweight---	64
Or aqua ammonia 26° at 5 cents-----	\$60
Bleaching carbon, Norit grade:	
1 ton, 2,000 pounds, at 5 cents-----	100
Or 2,000 pounds at 15 cents-----	\$300
Or 2,000 pounds at 25 cents-----	500
Total per day-----	569
25 days per month at \$569-----	14, 225
Or, per year-----	170, 700

Attention is called to the fact indicated by this prospectus that with potash selling at \$2.50 per unit this plant could be made self-supporting on the basis of potash alone.

We have set ourselves the task of realizing this prophecy, with the exception of the production and sale of ammonia, within the current fiscal year. Since it is believed that profit can be shown without ammonia, in view of the limited funds at our disposal for the current year and the expense (in materials, labor, and especially in time lost) in experimentation with retort furnaces, and since the full retort capacity will be needed for the production of bleaching carbon, it would appear to be wise to proceed with all dispatch to putting the plant on a producing basis with respect to potash, salt, carbon, and iodine, and to look to these for proceeds and profits. We believe that with these alone we can show a profit by the end of the year and that this fact should justify the acceptance of our recommendation that the enterprise be continued and enlarged until it can show whether or not the various other by-products now under investigation can be commercialized and likewise whether or not the process here employed is the most economical one.

In this connection it should be recalled that at the time the initial authorization was enacted three processes were under consideration; namely, (1) the destructive distillation of kelp, the process now under successful development here; (2) the fermentation of kelp; and (3) the manipulation of kelp to yield feed materials and potash. The second of these was subsequently tested on a magnificent scale by a powder company, at the expense of several millions of dollars, full details of which are now in our possession and will be made a part of the department's records. The third remains to be developed, but preliminary experiments, both here and in France (the latter as a war-time investigation to develop a new source of feed for army horses), strongly indicate that it is entirely feasible while obtaining potash, to prepare a cattle feed in nutritive value of about the grade of oats.

It is the purpose, then, during the year now beginning, to emphasize production and to bend especial effort toward the produc-

tion on the plant-capacity scale of the main and side products yielded by the process developed and now obtainable with the apparatus installed or about to be installed. At the same time, it is not intended to discontinue researches looking to the development of other products and processes, but on the contrary to pursue them with all the energy which the circumstances will permit. Effort is now being made to secure the services, on a permanent basis, of a research chemist who will reside here and work in the plant laboratory and give the various research problems his undivided attention. The advantage of a thorough laboratory investigation as the preliminary of any attempts to institute plant-scale changes in processes is so marked and its economy is so well recognized that it now seems advisable to await fuller experimental data obtained on the smaller scale before proceeding on the larger scale.

The opportunity for other and more detailed researches on kelp and kelp products is excellent. The field broadens tremendously as progress is made. A materially enlarged staff of chemical engineers, or chemists and engineers, could be advantageously applied to the study of these if funds and program warranted. It would be the greatest mistake to permit the present opportunity to pass without a complete study and solution of the more important of those.

SUMMARY.

(1) At the approach of the end of the second year of operation of the experimental kelp-potash plant, by-products have been discovered, developed, and their commercial obtainability established, which afford every assurance that kelp is to prove a profitable source of American potash, and that the department's work at Summerland will result not only in its complete justification, but also in the establishment of a kelp-potash industry of a substantial nature.

(2) As the year's program it is proposed to produce as many of those products as possible on a large scale in order to demonstrate profits. It is believed that the end of the year will find the plant on a paying basis.

SOIL PHYSICS.

During 1919 the regular research work in soil physics was largely suspended, owing to the employment of the force on nitrogen fixation work, but the routine work of the division was carried on as usual. The machinists were called upon to furnish a great deal of special apparatus and equipment needed in investigational work on war problems. Because of their special knowledge of the physical factors involved, the larger part of the personnel of the division was utilized in work on the synthesis and oxidation of ammonia, carried on in cooperation with the Bureau of Ordnance, Nitrate Division, of the War Department. The work done was of much assistance to the War Department in solving problems involved in perfecting processes for the fixation of atmospheric nitrogen.

REPORT OF THE ENTOMOLOGIST.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., August 14, 1919.

SIR: I submit herewith a report of the work of the Bureau of Entomology for the fiscal year ending June 30, 1919, following your directions as to arrangement.

L. O. HOWARD,
Entomologist and Chief of Bureau.

HON. D. F. HOUSTON,
Secretary of Agriculture.

CEREAL AND FORAGE CROP INSECT INVESTIGATIONS.

The work of this section, continued under the charge of Mr. W. R. Walton, has been of especial importance during the past fiscal year.

EUROPEAN CORN BORER.—In the last annual report of the bureau it was pointed out that this recently discovered insect, accidentally imported from Europe and thoroughly established in a limited region in eastern Massachusetts, threatened to become a pest of great importance throughout the corn-growing regions of the United States unless immediate measures were taken to stop its spread. Shortly after its discovery in 1917, it was shown to occupy apparently an area of about 100 square miles in the immediate vicinity of Boston. Later it was found in the Mohawk Valley of eastern New York, and careful scouting work showed that by the autumn of 1918 it had spread over an area of some 400 square miles. Scouting work in Massachusetts during the autumn of 1918 and the early spring of 1919 showed a distribution throughout 500 square miles of territory. A very vigorous campaign, looking toward extermination, was begun under State agricultural organizations; the New York Legislature appropriated \$100,000, the most of this sum being spent in the spring of 1919, and it is believed that much good was accomplished. A cooperative campaign was started in Massachusetts by Federal and State authorities under a State appropriation of \$50,000, and a considerable part of the infested area was treated in the effort to prevent the natural spread of the insect. A Federal appropriation was asked for, but the bill failed to pass Congress, and all of the work done in the spring of 1919 was carried on with funds provided by the States of New York and Massachusetts. The vulnerable point in the insect's life history is in its hibernation as a caterpillar in the stalks of corn and in the stems of other plants which it attacks, and there is a large list of these. Therefore the most effective work can be done only when the insect is in hibernation; and by the failure of

the Federal appropriation the opportunity for very effective work was lost. The result was that, with the appearance of the moths issuing from untreated or imperfectly treated areas in Massachusetts, there was a spread at the end of the fiscal year, so that at the date of the present writing the insect is known to occur over an area of 1,000 square miles, extending from the New Hampshire border on the north to the towns of Marshfield and Brockton on the south, and to the west into the towns of Lincoln and Wayland.

Much new and valuable information regarding the habits of the insect was gained during the year, and several publications were issued by Federal and State organizations, including a Farmers' Bulletin (No. 1046) from the United States Department of Agriculture, giving information as to the best means of destroying the insect in its winter quarters. Several more or less effective means of destroying infested plants were discovered, and it is now being arranged to put these into operation on a large scale immediately after the expiration of the growing season of 1919. Fifteen trained entomologists are now investigating the habits and methods of destroying this pest, and every possible effort will be made to prevent its further spread.

THE HESSIAN FLY.—The annual spring survey of Hessian fly conditions has recently been completed and indicates plainly that this well-known pest is rapidly increasing in abundance in many localities, and has been responsible for a considerable amount of fallen grain in the States east of the Appalachian Mountains, especially in the Shenandoah and Cumberland Valleys. Reports from the western half of the Mississippi Basin also indicate a distinct increase. Warnings have been issued through the news service of the department so that wheat growers may plant at the proper date in the fall of 1919 in order to avoid loss.

THE NORTHERN ARMY WORM.—The true army worm appeared in numbers during late May, 1919, in northern Texas, and damage was done to growing grains soon afterwards through Oklahoma, Missouri, Iowa, Illinois, and western Ohio. The usual remedies were successfully applied in most of the infested territory. In eastern Indiana a serious local outbreak was successfully handled by the county farm advisers under advice from this bureau. In this case the poisoned bran bait was used with excellent effect.

THE SOUTHERN CORN ROOTWORM.—As a result of recent investigations, it has been found that in large portions of the States of Georgia, North Carolina, and South Carolina corn planted before March 31 or after May 10 is more or less immune from the attacks of the southern corn rootworm. The Coastal Plain, however, from southern Virginia to Florida differs, and no regulation of planting time seems seriously to affect the insect in this region.

THE ALFALFA WEEVIL.—A successful method of spraying alfalfa to destroy the alfalfa weevil has been found, and its efficacy thoroughly demonstrated in Utah. It is possible to apply this method successfully at a cost not to exceed \$1 per acre, and serious losses, even to the first crop of alfalfa, can be avoided. This first crop, under previous methods of control, was usually sacrificed. The large-scale use of this method during the early part of 1919 resulted so

advantageously that the method will undoubtedly be generally adopted. The alfalfa weevil is at present causing much concern in Colorado, and spraying work has been undertaken in cooperation with the officials of that State.

GRASSHOPPERS.—Much valuable assistance in the form of personal advice has been given to State and county officials in the successful conduct of grasshopper extermination work throughout the States of North Dakota, South Dakota, Minnesota, Iowa, Montana, California, Kansas, Nebraska, Missouri, Oregon, and Washington during the summer of 1918 and spring of 1919. The loss of many hundred thousand dollars' worth of crops has been prevented as the result of these activities.

OTHER INSECTS AFFECTING CEREAL AND FORAGE CROPS.—Studies of the jointworms have been continued with excellent results. Control experiments with the alfalfa-seed Chalcids have been carried on in cooperation with the Arizona Commission of Agriculture and Horticulture in the Buckeye Valley of Arizona, resulting in an apparent decrease of 15 per cent in the infestation and a net profit of more than \$43 per acre in the experimental plot.

Experimental control work on the coulee cricket conducted during the spring of 1918 was apparently successful, and the insect has made no destructive appearance during 1919.

Studies of the alfalfa caterpillar, the harvester ant, white grubs, billbugs, wireworms, and the European sawfly in wheat have been continued with favorable results. The last-named insect has been watched with especial care, because it seems capable of doing considerable damage to the winter wheat crop under conditions favorable to its multiplication.

STORED-PRODUCT INSECT INVESTIGATIONS.

Dr. E. A. Back has continued in immediate charge of this branch of the bureau's work.

CORN WEEVILS.—During the past year a laboratory has been established at Orlando, Fla., for the purpose of studying the biology and methods of control of corn weevils. Enough has already been learned of the biology of these insects to form the basis for control work. At Athens, Ga., an office has been established in cooperation with the Georgia Agricultural Experiment Station, from which expert information regarding preserving corn from weevils has been disseminated among southern farmers.

BEAN AND PEA WEEVILS.—The great increase in weevil losses to California-grown beans and peas during the past few years has led to the establishment of a laboratory at Alhambra, Calif., at which the causes for weevil increase and the methods of control are being investigated. The work has received the hearty cooperation of the bean growers and warehousemen of the Pacific coast.

FLOUR BEETLES.—The biology of various species of flour beetles of the genus *Tribolium* that attack flour in all warehouses throughout the United States is being made the object of an especial investigation with headquarters at Dallas, Tex.

FUMIGATION AS A CONTROL METHOD FOR STORED-PRODUCT INSECTS.—Experimental work to determine the usefulness of fumigation in lessening or preventing the enormous waste taking place through insect attack to stored goods in warehouses, though as yet extending over only a short period, has yielded practical results of great value.

ELECTRICITY AS A CONTROL AGENT.—During the past year cooperative work has been carried on to determine the effectiveness of electricity as a control agent in the suppression of insects in cereals in package form. A commercial machine for sterilizing cartons of cereals after the latter have been sealed has been installed in a large cereal factory, with every promise of practical value. Should expectations be realized, the electrical treatment will result in great saving both to producers and consumers.

COLD STORAGE AS A CONTROL MEASURE.—The value of cold-storage temperatures in preventing insect damage to warehoused products has already been proved. Cold storage is being depended upon by wholesale and retail dealers of certain classes of foods and other products as the only satisfactory method of protection from insects. Detailed data regarding the effect of low temperatures upon various insects attacking stored products are being secured.

HOUSEHOLD PESTS.—Investigation of household pests other than the bedbug, flies, and mosquitoes, which was discontinued during the war, has been resumed. Several pests that are believed by the general public to be limited to houses, as clothes moths, cockroaches, and carpet beetles, have been found to be frequently very injurious to valuable materials stored in warehouses throughout the country.

INSPECTION AND INTELLIGENCE SERVICE.—The arrangements made during the war with the Quartermaster Department of the Army at the port of New York, whereby the bureau has undertaken to make frequent inspections of food and clothing supplies, proved so satisfactory that they have remained in force and are being extended to other food depots, not only of the Army but of the Navy. The purpose of this cooperation is to keep the Quartermaster Departments of the Army and Navy informed, through inspections made by bureau experts, not only of conditions of food supplies purchased and delivered at the warehouses, but also of their condition from time to time during the storage period. Such inspections detect and lead to the checking of insect ravages before the insects have had a chance to multiply and cause great loss.

The dissemination of information regarding the suppression of insects affecting stored food supplies and food products, which during the past two years has monopolized the efforts of this branch of the bureau work, is being continued, although the return to a peace basis is making it possible to open up the new lines of research indicated in preceding paragraphs.

DECIDUOUS FRUIT INSECT INVESTIGATIONS.

Investigations of the insects of this class have been carried out under the direction of Dr. A. L. Quaintance, as formerly.

APPLE INSECT INVESTIGATIONS.

COBBLING MOTH.—Detailed life history studies of this insect, under way for some years in different parts of the country, were begun

during the fiscal year in two new localities, and much additional knowledge, especially with reference to climatic conditions as affecting severity of damage, has been obtained. Numerous localities reported unusual injury to apples about harvest time, from recently hatched larvæ producing the so-called "sting," and there was considerable demand upon the office for local studies of the life history of the insect as well as investigations in orchards to perfect spraying schedules. The "sting" damage to apples in one State was estimated to have caused a loss of \$2,000,000 and the sum total of injury done by this pest in different regions represents a very heavy tax on the apple growers.

In Colorado, where work is being done in cooperation with the State agricultural experiment station, the life history studies were completed and the work was confined to orchards. In the Grand Valley in this State codling moth losses have always been severe, and many orchardists have been unable to obtain satisfactory control, even by thorough spraying. Study indicates that this was due to lack of co-operation among orchardists thoroughly to spray over a large area. Consequently arrangements were made with a number of contiguous orchardists whereby they individually agreed to spray according to the department's recommendations, and thus try out on a large scale the effect of uniformity of spraying operations over hundreds of acres. This prevents the overflow of codling moths from poorly cared-for orchards into well treated orchards, and good results are expected.

Cooperative work in the Rogue River Valley of Oregon has been continued. The approximate dates when the larvæ of the different broods enter the fruit have been established, and a sound basis has been gained for a schedule of applications not only for apples but also for pears.

In the Ozark region in Arkansas similar work has been continued, and has been done cooperatively with the Bureau of Plant Industry on account of the importance of plant diseases in the orchards of that section. It seems probable that in that locality dusting can not be relied upon as a substitute for spraying. There are three full broods of the codling moth in this region and a partial fourth brood. There is a distinct interval between the appearance of the first and second brood larvæ, but from that date on they are continuously in the orchards. These life-history studies in this region have been practically completed, and a sound spraying schedule will probably be arranged by the close of the present season.

Work of this general character has also been carried on cooperatively in Delaware and in the State of Washington, and at the bureau's laboratory at Wallingford, Conn., the codling moth has also been studied. The insect in the latter region is much less troublesome than in the central, southern, and western regions, and it seems likely that a single thorough spraying at the time of the falling of the petals will prove sufficient to protect the fruit.

APPLE-TREE AND OTHER BORERS.—The work with the apple-tree and pear-tree borers has practically been completed, and publications will shortly be issued.

APPLE PLANT-LICE.—Intensive work has been done with these insects, especially with reference to the exact determination of alter-

nate food plants and the identity of certain confused forms. This has involved an enormous amount of work, and decisive results are about to be reached.

In addition to the apple insects mentioned above, a considerable number of other species which live in apple orchards have been studied, but most of these are of lesser economic importance in the general run of seasons. As it often happens, however, that one of these minor pests becomes for a season or more very injurious, it is necessary that the bureau should anticipate such outbreaks by securing thorough biological information.

GRAPE INSECTS.

THE GRAPE-BERRY MOTH.—Vineyards were selected in several widely separated sections of the northern Ohio grape belt to serve as object lessons for vineyardists and to give them personal instructions in spraying effectively. It has been shown that the grape-berry moth can be controlled by two applications of arsenate of lead in spray form, leaving the fruit practically free from residue at picking time. In certain cases a single application has been sufficient, but here there were no surrounding badly infested vineyards. This indicates that eventually a single spray in general will keep the pest in check.

THE GRAPE MEALYBUG.—Full life-history studies of this insect have been finished. Fumigation with cyanid of soda and with sulphur fumes has been satisfactory in the dormant season at night, but sulphur is considered the better. January has been found to be the best time for this work. Spraying has proved less effective than fumigation. A campaign of education among grape growers has been begun to secure their cooperation in restricting the spread of the pest on picking boxes and in other ways.

THE GRAPE PHYLLOXERA.—In collaboration with the Bureau of Soils of this department, a survey of Fresno County has been made to determine the influence of the physical nature of soils on the degree of infestation of vineyards by the Phylloxera. Interesting and valuable facts have been ascertained. Investigations have been made concerning the best methods of disinfecting grape propagating stock destined for shipment.

THE GRAPE SPHINX MOTH.—An interesting instance of the value of entomological knowledge occurred when this insect appeared in numbers in Tulare County during the fiscal year, over some 700 acres of vineyards. The bureau's agent cooperated with the vineyardists, and, at an outlay of about \$12,000 for labor, spraying materials, and machinery, the grape crop, valued at \$180,000, was saved.

A number of other grape insects have been studied and new biological data ascertained.

NUT INSECTS.

PECAN INSECTS.—Special attention has been given to the use of insecticides in pecan orchards in Georgia and Florida. Arsenicals are being tried in the form of dusts and sprays, and another season's work should show conclusively the comparative merits of these two methods. In Texas, the bureau has been especially interested in the native pecan groves along river bottoms and elsewhere. In these

native groves satisfactory control is very difficult and insect injury is quite severe; in fact, 90 per cent of the pecan crop here was lost during 1918. Three species of insects are principally involved.

INSECTS INJURIOUS TO WALNUTS, BUTTERNUTS, ETC., IN THE NORTHERN STATES.—This work, especially with the walnut curculio, the hickory curculio, and another species that attacks the leaf stems of hickory, and with other species as well, has been taken up by the bureau, with headquarters at French Creek, W. Va. A thorough investigation of insects attacking nuts other than pecan throughout the country will be carried on.

CRANBERRY INSECTS.

In the last annual report the beginning of the work on insects in cranberry bogs in the State of Washington was mentioned. This work, in cooperation with the Washington Agricultural Experiment Station, has been continued and important results have been reached. On bogs badly infested by the blackhead fireworm satisfactory results have been secured from three applications at intervals of from 17 to 21 days between May 1 and July 1 of nicotine sulphate containing 40 per cent nicotine used at the rate of 1 to 800, with the addition of fish-oil soap at the rate of 2 pounds to each 50 gallons, the spray being applied at the rate of 250 to 550 gallons per acre. Of the spray nozzles tested that known as the Bordeaux appears to be best suited. Growers have generally adopted this treatment and are getting good results. Detailed life-history studies of this insect are nearing completion, as are also studies of the cranberry root weevil. It has been shown of this latter species that it can be controlled by spraying the foliage during May and June with 2 pounds of arsenate of lead to 50 gallons of Bordeaux mixture.

A general survey of insect conditions is being made on cranberry bogs on the Pacific coast, and it is hoped that by the close of the season a report can be prepared on the principal cranberry insects of that territory.

PEACH INSECTS.

Tests of paradichlorobenzene as a treatment for the peach borer were continued through the growing season of 1918. Experiments with this gas have now been carried on during a period of three years in the peach districts of Maryland, Ohio, Arkansas, Virginia, West Virginia, and Georgia. In some cases blocks of trees have been treated two and three years in succession. It has been found that three-fourths of an ounce or 1 ounce of the chemical per tree applied in the fall after the moths have laid their eggs will result in the destruction of about 95 per cent of the larvæ. No injury has resulted from this dosage to trees 6 years old and over. Younger trees, on account of their thinner bark, have sometimes been injured.

Experiments as to the comparative merits of dusting and spraying in the control of the plum curculio and certain peach diseases have been continued in cooperation with the Bureau of Plant Industry at Fort Valley, Ga., Agricultural College, Miss., and Bentonville, Ark. The summer of 1919 has been an unusual one and control measures have been put to a severe test. The dusting method in a general way seems to compare favorably with spraying, even under the worst conditions.

THE JAPANESE BEETLE.

The introduction and establishment of this insect in the vicinity of Riverton, N. J., was mentioned for the first time in the last annual report. The work of eradication and control has been vigorously prosecuted in cooperation with the New Jersey State Department of Agriculture. The operations have been materially enlarged, but in spite of all that has been done the insect is increasing rapidly, spreading over new territory, and at the time of the present writing is perhaps 150 per cent more abundant than at the same time last year. Many experimental lines are being worked. Cyanid of soda in solution has been used to destroy the grubs in the ground, at the rate of 1 pound to 200 gallons of water and applied at the rate of 22,000 gallons per acre. While the beetles are flying, a wide barrier of poisoned foliage is maintained as completely as possible around the whole area of infestation. Where the beetles are most abundant they have been systematically collected in hand nets. An active collector can secure several quarts of the beetles in a day, and as each quart contains 4,000 individuals, this method is important. About 1,000,000 beetles have already been collected. Plowing the soil infested by the grubs and pupæ appears to destroy them. It will be necessary to do this kind of work very extensively in waste places and many areas not under cultivation. Weeds along the roadsides have been burned to destroy their food and render such places unattractive to the beetles, thus reducing the danger of their being carried by vehicles, pedestrians, and so on. In the same way, waste places along ditches and other spots which can not well be treated with cyanid are being cleared of weeds, and this work is being extended into the wide barrier of poisoned foliage surrounding the area of infestation. Close study is being made of the relative abundance of the insect in different parts of the area and on the methods of dissemination, and a quarantine is in force providing for the examination and certification of green sweet corn going out to market, since the beetles penetrate the tips of the ears and could thus be widely spread. A local citizens' committee has been established, which is of greatest assistance in the work of arranging cooperation of property holders with the agents of the bureau and the State. The work is now well organized, and we have a much better idea of the problem. It seems, from the rapid increase and spread of the insect during the summer of 1919, that the work must be greatly enlarged to be entirely successful.

INSECTICIDE INVESTIGATIONS.

At the various field laboratories tests have been made of many proprietary insecticides in comparison with homemade articles.

Work on the so-called "Derris," an insecticide made from plants of the genus of this name, has been completed. If this insecticide can be obtained in sufficient quantities it will prove an important addition to our list of substances that kill soft-bodied insects like plant-lice.

Studies of the various arsenical insecticides, like arsenate of lead, arsenate of lime, zinc arsenite, and so on, have been continued. Large-scale feeding experiments have been carried on with caterpillars and other insects. Experiments under different climatic conditions with these substances have also been continued. Additional expe-

rience confirms the conclusion reported last year that arsenate of lime may be used in all situations as a substitute for Paris green, and that it will also, for pomaceous fruits, prove a satisfactory substitute for arsenate of lead when used with lime or fungicides containing lime.

It has been shown that nicotine sulphate is an unsatisfactory substance to use against the eggs of the codling moth in the field. Nicotine is, however, coming rapidly into use as an insecticide in other ways, and the bureau has been trying to find a less expensive substitute. The results already obtained are promising. Basic studies in connection with this work have been made on the physiology of injurious insects, especially on their olfactory organs, and a number of publications have been issued on this subject.

NATURAL CONTROL.

Under this head, studies of insect-destroying fungi have been continued, especially a fungous disease of cutworms. An obscure disease of the so-called seventeen-year locust, or periodical Cicada, has also been studied.

Work with the ladybird known as *Hippodamia convergens*, in the Imperial Valley of California, has been continued in cooperation with the California State Horticultural Commission, especially in regard to certain needed changes in the method of handling the insects. This work will be continued.

An especial study has been begun of the natural enemies of the plant-lice which are injurious to walnuts in southern California.

INVESTIGATIONS OF INSECTS INJURIOUS TO VEGETABLE AND TRUCK CROPS.

Work upon this group of insects has been continued as heretofore under the direction of Dr. F. H. Chittenden. Under the necessity for stimulation of food production much of the research conducted on the less important subjects under this head was temporarily discontinued, and attention was especially directed to the important staple crops.

SWEET POTATO WEEVIL ERADICATION AND CONTROL.

Continuing the policy of the fiscal year 1918, under a \$50,000 allotment for the eradication and control of this insect, intensive work was done. The definite boundaries of infestation were established in Florida, Georgia, Alabama, Mississippi, Louisiana, and Texas. More than 30,000 farms were inspected during planting and harvest (since at these times the presence of the weevil is most apparent), and the infested properties were listed and mapped. Large-scale experiments in control have been continued. In one large eradication project in Florida, selected for demonstration since it embodies most of the serious difficulties to be encountered, material progress has been made. All of the infested estates have been subjected to continuous supervision, contracts have been made with the growers for the destruction of all seed potatoes grown on infested land, and the scrupulous execution of these contracts has been rigidly enforced. More than 1,000,000 weevil-free sweet-potato draws have been distributed to growers by

cooperation with the Florida State Plant Board. This materially aids in the eradication of the weevil without interfering with the production of potatoes, since the contracts provide for clean culture and a fallow period of six weeks prior to planting, together with other repressive measures. It is believed that as the result of this work the end of the growing season will find this locality practically, if not completely, weevil free.

In Alabama, the infestation was found to be confined to a single well-defined locality in Baldwin County, and excellent cooperation has been secured with growers toward the application of all necessary repressive measures. It is believed that this isolated outbreak will be entirely cleaned up in another season.

In Mississippi the passage of a drastic crop-pest law materially aided in the eradication measures, the establishment of a quarantine rendering complete control of intercounty shipments possible. The comparatively light infestation in this State has been mapped, and a material reduction of the area infested has been secured.

In Louisiana survey work has been continued, and growers have been visited and urged to apply methods devised by the bureau. Reinspection recently indicates that gratifying results have been reached in the majority of cases. A careful study has been made in this State as well as in Mississippi of the other food plants of the morning-glory group, especially the large-rooted perennial morning-glories, and a number of chemicals have been tested as weed killers, to be used against these wild food plants.

In Texas, 85 counties have been found infested with the weevil, which has been distributed apparently largely through commercial growers of slips shipping from the Gulf and south-central portions of the State. There is no law in Texas controlling the shipment of infested plant material, which is a serious drawback to the control of the weevil in that State. The fact that salable sweet potatoes can not be produced in some of the coast counties has helped the widespread distribution of the weevil, as draws grown from unsalable stock often prove more profitable than the growing of tubers. Life-history studies at Kingsville, Tex., showed at least six generations of the weevils annually, indicating an enormous rate of increase. Spraying experiments at this point have reduced infestation from 44.51 per cent to from 2.88 to 12.18 per cent.

INSECTS AFFECTING POTATO, TOMATO, AND ALLIED CROPS.

The potato aphid, an unexpected pest which made its appearance in 1917 and again in the early summer of 1918, was experimented with on into July, 1919. The use of nicotine sprays at increased strengths demonstrated practical control in Maryland, New Jersey, and Maine.

The spinach aphid, which has during recent years become troublesome as a potato pest, and which also affects cabbage, beets, lettuce, and other staple vegetable crops over a still wider range of territory, has been the subject of continued investigations along the Atlantic coast. A new station in the Aroostook region in Maine, a great potato center, has been established for the study of the Colorado potato beetle, the potato flea-beetle, and other potato pests. An investigation of the spread of the Colorado potato beetle on the Pacific

coast has been conducted. The infested localities have been mapped and a campaign has been begun to spread a knowledge of the importance of control measures.

Other potato insects have been studied in Wisconsin and Iowa.

INSECTS AFFECTING GROWING BEANS AND PEAS.

The bean ladybird has recurred in numbers in Colorado and New Mexico. Experiments have shown that it can be controlled with lead arsenate and zinc arsenite sprays.

The enormous plantings of beans in southern California, owing to war conditions, resulted in serious injury to the crop from the corn earworm, and investigations of this insect under these conditions have been made. The tremendous spread of this crop resulted in the great multiplication of the insect, and with the reduction of the bean acreage this season serious damage will very likely result from the abundance of the pest.

The pea moth, an imported pest already well established in Canada, has made its appearance in injurious numbers in Wisconsin, where it seems to be greatly increasing in number, necessitating additional investigations of its life history in order that a sound remedy may be established.

INSECTS INJURIOUS TO CABBAGE AND ALLIED PLANTS.

An investigation of the western cabbage flea-beetle, a pest of much importance in the Western States, has been completed, and the results are available for immediate publication.

The harlequin cabbage bug, after one of the periods of inactivity in the North which have several times been noted, is likely now to reinfest its northern range at any time, and an emergency bulletin on methods of control has been prepared.

An imported horse-radish pest, hitherto known as injurious only in Canada, has made its appearance in destructive numbers in Virginia, and is being studied. It will live on other crucifers, and if not controlled may become a pest of much importance.

SUGAR BEET INSECTS.

Work on the sugar beet leafhopper, which is the cause of the malady known as "curly-top," was terminated at Spreckles, Calif., and the station was removed to Riverside that the study of certain points in the life history of the insect and the relation of temperature and humidity to its development might be completed. A considerable percentage of parasitism has been observed during the year.

OTHER TRUCK CROP INSECTS.

Much good work was done with a number of other insects, including the onion thrips and the onion maggots, the melon aphid, several strawberry insects, and others. A notably good result was obtained in the case of the celery leaf-tier, since it was demonstrated that it could successfully be controlled by spraying with arsenate of lead at the rate of 1 pound to 50 gallons of water, the first spray to be made when the eggs are hatching and repeated every two weeks as long as the "worms" are to be found. This was accomplished at a cost, for labor and material, of \$2.35 per acre.

INVESTIGATIONS OF INSECTS AFFECTING FOREST RESOURCES.

The work in forest entomology has been continued during the past year under the direction, as before, of Dr. A. D. Hopkins. The results accomplished by this section of the bureau deserve especial mention and justify the expenditure of a larger sum of money in this direction.

WESTERN FIELD WORK.

An especial investigation of the insect damage to crude spruce products for airplane stock in the States of Washington and Oregon showed that the greater part if not all of the damage could be prevented by proper methods of logging and production with little or no additional cost.

Exhaustive studies of insect investigation and control were continued in the Sequoia and Yosemite National Parks. Much new information has been gained, and the methods of gathering and compiling field data have been standardized.

A special study was completed on the interrelation of forest fires and insects on an area of about 8,000 acres in southern Oregon. This area had been under observation since 1914, and the fire had burned over about 800 acres in 1918. The records show that previous to the fire the insects had killed 485,000 board feet of timber. The fire killed 170,000 feet, and subsequently the slightly fire-injured as well as the uninjured trees in the burned area were killed by beetles, which were attracted from the surrounding areas. It was noticed that the infestation in the burned area increased more than 1,000 per cent, but it was found that the infestation in the surrounding areas decreased. It was also found that the broods of the beetles in the fire-scorched trees failed to develop to much beyond the original number that attacked the trees. So the fire did not contribute to an increase of the beetles in the general area or to the starting or extension of an epidemic of beetles. This result is of extreme interest and hardly to be expected.

The most careful study ever made of the history of an epidemic infestation by tree-killing beetles was completed and a report submitted during the year. In the Rogue River area in about 48,000 acres near Ashland, Oreg., the western pine beetle in 1914 caused the death of 346,000 board feet of pine timber. In 1915, 1,615,000 board feet were killed; 1,383,000 feet in 1916; and 608,000 in 1917. A count of the young and matured stages of the beetles that developed in an average foot of bark, and also of the number of exit holes through which the beetles emerged to attack other trees, showed that there was a notable decrease in numbers during the development of the broods each year in the infested trees on account of the increase of natural enemies and other disturbing factors. This helps explain why these beetle epidemics rise and fall within a limited period of years, and it explains how the western forests of yellow pine are naturally protected from total destruction. These facts are especially significant in connection with the application of the percentage principle of control, as by aiding the natural forces which work against the abnormal increase and spread of the beetles complete control may be gained. The history of this epidemic shows the importance of prompt recognition and prompt treatment of a threat-

ened outbreak in order to prevent the great loss of timber which would occur before natural control became operative.

Another special study was made of the number of all stages of the western pine beetle in 330 square feet of infested bark selected from 67 trees, which represented an average infestation within an area of approximately 36 square miles. It was shown that there is a large percentage of mortality between the young and matured stages in the developing broods, but that normally an average of about 150 beetles to the square foot of bark developed to the adult, or reproductive, stage; which would be 50,000 beetles to the average infested tree, or, say, 39,000 beetles to 1,000 board feet of timber. Since it requires an average of about 10 beetles to the square foot to attack and kill a vigorous, healthy tree, it will be seen that all the pine timber of the western forests would soon be destroyed were it not for natural and artificial control.

Experiments to determine the time of year to cut and the methods of handling mesquite for fuel, posts, etc., to avoid destruction by wood-boring insects, have been nearly completed, and the results show that serious loss in the Southwest can be prevented by cutting the trees in the late fall and early winter and piling the wood in loose piles until it is thoroughly dry. Damage to posts can be prevented by cutting them at any time and laying them on the ground where they will receive the full force of the sun, turning them occasionally so that the young stages of the borers will be killed by the heat.

Studies of damage to lead telephone cables in California by a wood-boring beetle have been continued, and the results so far show that the beetle is able to penetrate alloyed substances that are considerably harder than lead. The problem is still unsolved, and it will be difficult to find a practical means of controlling this pest, which is able to put hundreds of telephones out of commission by boring holes in the cables, through which the water enters, rendering the wire connections useless until the place is found and repaired.

EASTERN WORK.

Continued experiments with chemical substances applied to finished and crude forest products show that very few of the many substances that have been tried are effective, and, with crude products, none of them are so economical as simple and inexpensive management in logging and manufacture which will render the conditions of the bark and the wood unfavorable to attack.

Continued studies of termite, or white ant, damage to the woodwork of buildings has led to the discovery that one of the most destructive species can not live if deprived of moisture in ground or foundation timbers; thus it is possible to prevent serious damage.

Investigations of shade-tree insects have continued, and there has been much correspondence about insects of this class.

The recent appearance of the so-called seventeen-year locust, or periodical cicada, has given an opportunity for detailed study of certain points, and motion pictures have been made.

STUDIES OF THE BIOCLIMATIC LAW.

A law of latitude, longitude, and altitude as a guide to practice in fighting insects, and of value in the practice of agriculture, was first

worked out by Dr. Hopkins, the chief of this section, in relation to forest and other injurious insects. It has proved, however, of such wide application that he has worked upon its various aspects with much assiduity. Extensive studies of the advance of the spring season were carried on over a large portion of the United States, and over 19,000 records of periodical events in plants and insects were made in the East. The most important result of this special study of the advance of spring is in the almost complete verification of evidence in support of the law that has been formulated from a preceding study of 40,000 records of reported dates of wheat harvest and of records of altitude limits of life zones. Applications of this law appear to be of great value in the study of all problems relating to periodical farm practice, the warfare against insects among others.

TROPICAL AND SUBTROPICAL FRUIT INSECT INVESTIGATIONS.

This branch of the bureau's investigations is under the charge of the assistant chief of the Bureau, Mr. C. L. Marlatt,

INVESTIGATIONS OF INSECTS AFFECTING CITRUS FRUITS IN CALIFORNIA.—A considerable portion of the time of the investigators assigned to this project has been devoted to extension work in connection with the efforts to stimulate production as a war measure. The research work of this station has been continued with respect to the investigation of the availability of liquid hydrocyanic acid for the fumigation of citrus trees and the control of citrus mealybugs and the Argentine ant. For the purpose of experimentation with the liquid hydrocyanic acid, a 600-acre citrus ranch at Orange was placed at the disposal of the agents of this department, and very careful records have been kept on the subject of dosage, exposure, and effect of meteorological and soil conditions, and also of previous insecticidal treatments. Paralleling these orchard experiments, certain necessary physical and chemical examinations have been made of the liquid cyanid, involving the examination and analysis of over a hundred different samples to determine variation in the chemical composition and the causes of such variation, involving both methods of production and impurities. This investigation has resulted in the determination of proper dosage tables for effective use against the different scale insects infesting citrus trees under the different conditions outlined—tables which have been published and are now available and are being generally followed in orchard work in southern California.

The control of the Argentine ant, which has rapidly spread during the last few years in the citrus districts in California with the resultant large increase of damage by mealybugs, which it harbors and distributes, has been continued and a more efficient ant poison has been developed especially in its application to the dryer conditions of California. Demonstrations with this poison in the control of ants and the attendant mealybugs have been made at the various places in the principal citrus-producing counties of California. A method of control of the citrophilus mealybug, which has recently become a very serious pest in limited regions of the citrus belt of California, by banding and the use of ant poisons, has been developed which has resulted in one of the most notable successes in

insect control done in the State. This method of control has practically eliminated this mealybug from upward of 500 acres near Upland, Calif., and, in fact, over most of the district infested by this insect, and for the first time in years the owners of these orchards are able to sell their fruit in prime condition at the highest market price. This method of control will be rapidly extended over the entire infested district.

In connection with the investigation of the two principal mealybug enemies of citrus plants in southern California, the parasitic and predatory enemies of these insects have been further investigated as also the symbiotic relations of these insects with the Argentine ant.

The department has cooperated with the California authorities in the determination of the best methods of exterminating the European snail (*Helix pisana*) which has become established in a small canyon or district near San Diego. As a result of this investigation and of various conferences the method of control now being carried out by the State is the burning over of the district with torches fed with oil under pressure totally to destroy the vegetation. This snail was possibly introduced by some foreigner familiar with its food value in Europe, without thought as to its tremendous possibility for harm to cultivated crops.

CITRUS FRUIT INSECTS IN FLORIDA.—The work under this project during the year has been largely limited to demonstrational work in the aid of increased production. Spraying demonstrations have been conducted widely throughout the State. A revised schedule for fumigation and treatment of trees to prevent insect injury has been worked out for the grapefruit, and a Farmers' Bulletin (No. 1011) has been issued entitled "The Woolly White Fly in Florida Citrus Groves." Some special lines of investigation have had to do with the stabilizing of insecticides especially where the only water available is obtained from deep wells containing a large percentage of mineral elements which more or less affect the stability of certain emulsions and other insecticides. The work in Florida has had particular relation to the citrus white fly, the rust mite, and the common Florida scale insects. The work in the control of citrus pests in Florida has shown the greater availability of liquid sprays over the fumigation methods commonly followed on the Pacific coast. During the last two years, however, considerable demonstration work has been done with fumigation in Florida by a private concern, the results of which have been carefully examined by the expert of this department as a protection to citrus growers and to determine that any claims made are fully justified.

INVESTIGATIONS OF INSECTS AFFECTING MANGO, GUAVA, AVOCADO, AND OTHER SUBTROPICAL FRUITS.—The mango and avocado and other fruits mentioned under this heading are being commercially developed on a considerable scale in southern Florida. A station has been established at Miami in cooperation with the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry of this department to investigate the peculiar insect enemies of these fruits. Due to the proximity and commercial connections of southern Florida with Bermuda, the West Indian Islands, and Central America, this region is especially open to invasion by important fruit pests, and several of these have already gained entrance. One feature of the project,

therefore, is to cooperate with the Federal Horticultural Board in safeguarding against further introductions of such insects from the sources named. The work of the last year under this station has had particular relation to several important insect enemies of the avocado. Already effective means of control of the principal avocado insects have been devised, notably with respect to leaf-infesting mites, to species of thrips, and several scale insects. Work has also been done with respect to insect enemies of the mango and the papaya.

STUDIES OF GREENHOUSE INSECTS.—Under this project, life-history studies and methods of controlling the chrysanthemum midge, a very important injurious insect of this plant in eastern greenhouses, have been completed and presented for publication. A bulletin (Department Bulletin 778) has also been published during the year giving the life history and methods of controlling the rose midge. Work has also been done with respect to the effective utilization of various insecticides and in the general problem of fumigating plant houses.

MEDITERRANEAN FRUIT FLY AND MELON FLY.—This work is a continuing one, and has been carried on at the bureau's laboratory in Honolulu. The research features of the work have consisted in further studies of control by the agency of parasites and natural enemies. The principal work, however, has remained as heretofore in the inspection and certification of bananas, pineapples, taro, and coconuts for shipment from Hawaii to the mainland of the United States.

GEOGRAPHICAL DISTRIBUTION OF FRUIT FLIES.—The work under this project has for its special object the surveys of districts contiguous to the United States, from which the importation of fruit and plants may be the means of introduction of fruit flies and other enemies of important fruit crops. During the past fiscal year the field work under this project has involved explorations of the Panama Canal Zone, British Guiana, and the West Indian Islands of Barbados, Trinidad, Tobago, and Grenada, continuing the work which was done the previous year in Cuba, Jamaica, Dominican Republic, and the Virgin Islands. In the course of this work a great many insects have been collected and studied of known or potential economic importance and in addition a very considerable miscellaneous collection of insects has been made. The investigations were conducted in plant gardens maintained by the local departments of agriculture of the different islands and such general surveys as were possible within the time limits. Particular attention has been paid throughout the work to fruit flies, scale insects, and such other pests as are particularly likely to be carried from country to country by traffic in fruits and plants. A good portion of the time of the expert engaged in this work is necessarily devoted to the identification of the material collected and the working up of results.

INVESTIGATION OF FRUIT FLIES AND OTHER TROPICAL AND SUBTROPICAL FRUIT INSECTS IN THE CANAL ZONE, PANAMA.—This is a new project which has been established in cooperation with the authorities governing the Panama Canal Zone and the Federal Horticultural Board to study the important insects infesting tropical and subtropical fruits, cultures of which are being developed under the encouragement of the Government authorities in the zone. The importance of this investigation is due to the fact that the several important

fruit flies and other tropical and subtropical fruit insects are now established in the zone, and to the further fact that the zone is more or less of a world's crossroads, i. e., a place where insect pests from remote places may be carried through the agency of commerce and easily gain lodgment, later, perhaps, to effect entry into the mainland cultures, tropical and subtropical, of the United States. This work, now in progress for one year, has developed useful information. Much work has been done in connection with the so-called black fly of citrus and other plants, which has become established in the Canal Zone and in the West Indies, and which a very determined effort is being made to exclude from the southern United States. A considerable number of other important injurious insects have already been discovered and have been the subject of studies. Among these are no less than four different kinds of fruit flies. There have been found in the Canal Zone also a number of insects which very injuriously affect commercial woods and wood structures. Termites are very important subtropical insects found in the Canal Zone. Several of these are abundant in the State of Panama and several have been found in the Canal Zone, some of which are very destructive to garden crops. The entrance of some of these into the United States would be followed by great injuries. The number of subjects which have been investigated at this station is already enormous, and a very convincing showing has been made of the need of keeping constantly in touch with the plant cultures and insect enemies in this district as a means of benefiting local production, but particularly as furnishing information on which any necessary protective action in the interests of the United States may be taken.

WORK ON THE GIPSY MOTH AND BROWN-TAIL MOTH.

This work has been continued under the supervision of Mr. A. F. Burgess, with headquarters at Melrose Highlands, Mass.

For the first time since the bureau began work to prevent the spread of these insects, it is possible to report a substantial decrease in the infested territory. This amounts to 1,824 square miles previously infested with the gipsy moth and 5,385 square miles by the brown-tail moth. Twenty-eight towns in New Hampshire, 6 in Vermont, 8 in Massachusetts, and 10 in Connecticut, 52 towns in all, were found to be free from gipsy moth infestation and were eliminated from the quarantine area this year. There is now under quarantine on account of the infestation by the gipsy moth 20,747 square miles in New England. Isolated colonies of the gipsy moth, which were found in previous years in New York, Ohio, New Jersey, and the western part of Massachusetts, have again been carefully examined but no infestation found. There seems to be no reasonable doubt that the insect has been exterminated in these colonies.

The decrease in area infested with the brown-tail moth includes 34 towns in Maine, 58 in New Hampshire, 6 in Vermont, 37 in Massachusetts, and 10 in Connecticut, a total of 145, embracing an area of 5,385 square miles which was released from quarantine this year. There are now quarantined on account of this insect 28,752 square miles.

FIELD CONTROL WORK.—The field work has been carried along on the same general lines as in previous years. As the scouting of the border area failed to reveal infestations in many towns, it was possible to devote more time and effort to the control of bad colonies located on exposed places in towns inside the border. Work of this character is exceedingly important, as it tends to reduce the opportunity for small caterpillars to be spread by the wind and helps to prevent new infestations from becoming established outside the border and in the area which has been cleaned. Scouting was carried on in 130 towns, and in a number of these towns the work was checked up by special scouts, known as trailers, to determine whether egg clusters were being missed. This method is constantly employed in order to keep the work on an efficient basis.

In the fall of 1918 several tons of gipsy moth banding material was prepared at the field storehouse at Franklin, N. H. About 4 tons of this material was applied to the trees early in the spring, and excellent results were secured. During the winter five of the horse-drawn spraying machines were converted into motor-propelled outfits and there were available 12 motor-truck sprayers and 7 horse-drawn machines, with the necessary hose, nozzles, and other accessories. These machines were distributed along the infested border and work was taken up as soon as the foliage was large enough to be sprayed. For the first time since the work began, dry arsenate of lead was used instead of paste. The results were satisfactory; and more of this material will be used in the future if the price is as favorable as is that of the paste form.

Spraying was carried on in 36 towns as follows: New Hampshire, 25; Massachusetts, 3; Rhode Island, 4; Connecticut, 4; 3,280 acres of infested woodland was sprayed; also 6,800 fruit and shade trees. This work in the border territory was greatly facilitated by the spraying carried on by the State entomologist in Connecticut. The work was arranged so that one motor truck furnished by the State and one horse-drawn sprayer treated the infestations in a number of towns.

EXPERIMENTAL WORK.—In the fall of 1918 many sample collections were made to determine whether the severe winter had adversely affected the imported egg parasites, namely, *Schedius kuvanae* and *Anastatus bifasciatus*. The results indicated that *Schedius* had not been able to survive the winter in New Hampshire, except possibly in a few of the more favorable locations. This species was also very scarce in Massachusetts, except in the southern part of the State. *Anastatus* came through the winter in better condition, although its numbers were decreased somewhat. Owing to these conditions, plans were immediately made to colonize large numbers of both species during the fall and winter.

Five million specimens of *Schedius* were colonized in Massachusetts and New Hampshire in the fall of 1918, and 10,000,000 specimens of *Anastatus* were colonized in the spring of 1919; 2,016 colonies of the latter were liberated in Massachusetts, 6,286 in New Hampshire, 1,659 in Maine, 127 in Rhode Island, and 144 in Connecticut. The completion of this work was made possible by assistance secured from the officials in the different States.

Compsilura concinnata was slightly less abundant than has been the case for the past three years, but in some localities it was present in satisfactory numbers. The species is widely distributed, having been recovered during the present summer in the Annapolis Valley in Nova Scotia. It attacks many species of native caterpillars and is particularly valuable on that account. This habit also makes it possible for the species to maintain itself in territory which is not infested with the gipsy moth or the brown-tail moth.

Blepharipa scutellata has been found more widely distributed this year than heretofore, and in some locations a fair degree of parasitism has been recorded. In the territory as a whole it probably has not reached its maximum numbers. Field collections indicate that *Apanteles melanoscelis* is not quite as abundant as was the case last year. This is evidently due to the work of secondary parasites, as many of these have been reared from cocoons of the second generation of *Apanteles*. This species probably has not increased to maximum numbers.

Calosoma sycophanta was not as abundant this year as heretofore, and this was particularly true in some localities where it had been very numerous during the past two or three years. The wilt disease was not nearly as common as usual and this condition seems to be rather universal throughout the territory infested with the gipsy moth. Further studies are being conducted relative to the Japanese disease of the gipsy moth (*Streptococcus disparis*), and more colonies are being liberated in order that a thorough study of its value may be made in the field.

While the area infested with the brown-tail moth was considerably reduced during the past year, the insect seems to be increasing slightly in the eastern part of the territory. Collections of brown-tail moth webs from 100 towns were made during the winter by State and town authorities and forwarded to the laboratory. Dissections of about 10,000 larvæ taken from these webs indicate that *Apanteles lacteicalor* was present in small numbers, while *Meteorus versicolor* was much less abundant. The most common parasite found in these collections was *Zygobothria nidicola*; 20 per cent of the caterpillars in the entire lot were parasitized by this insect.

Only a few localities have been found this summer where brown-tail moth caterpillars are at all abundant, and the fungus disease (*Empusa aulicæ*) has not been reported.

Work on a more effective material for banding trees is under way and preliminary tests to determine the relative value of dusting with arsenate of lead versus spraying have been started.

The study of the gipsy moth problem on cranberry bogs has been nearly completed and much valuable information secured.

The work of securing data on the mortality of different species of trees that have been defoliated is being continued and silvicultural investigations are being carried on principally on the sample plots established some years ago.

QUARANTINE WORK.—The quarantine of the areas infested with the gipsy moth and the brown-tail moth made necessary during the fiscal year the inspection of 29,394 shipments. These consisted of forest, nursery, and quarry products; also Christmas trees and greens.

In addition to the inspections made, 623 permits were issued to allow the shipment of material of this sort which originated outside the quarantined areas but was offered for shipment inside the areas.

PRESENT CONDITION OF THE AREAS INFESTED WITH THE GIPSY MOTH AND THE BROWN-TAIL MOTH.—The winter of 1917-18 was the most severe that has been experienced in New England for many years. Not only was the temperature abnormally low, but the snowfall was exceedingly heavy, except along the coast. These conditions were partly responsible for the failure of many gipsy moth eggs to hatch in the spring.

In the summer of 1918 serious defoliation by the gipsy moth existed in the Cape Cod region in Massachusetts, but small defoliated areas could be found in many other sections. Advantage was taken of this condition in planning the field work in the summer and fall of 1918, and, by taking advantage of the reduction in infestation in many localities, it was possible to clear many colonies.

The winter of 1918-19 was exceedingly mild and gipsy moth eggs survived and a very large proportion hatched.

Some of the parasites, particularly *Schedius*, which destroys gipsy moth eggs in the fall, were not nearly as numerous this year as heretofore, and the other introduced parasites do not appear to have fully recovered from the setback received during the previous winter. The wilt disease was also less abundant and effective this year than usual. As a result of these conditions heavy feeding by the gipsy moth has appeared over the greater part of the infested area in eastern Massachusetts and New Hampshire.

The present indications are that stripping will be more severe next summer, and if weather conditions are favorable for the spread of the small caterpillars by the wind next spring it will not be surprising if some of the recently cleared border towns become reinfested. The gipsy-moth problem is therefore more difficult than usual and the most strenuous measures will be necessary in order to hold the insect within the territory now infested until the parasites and diseases have become more numerous and effective in the worst infested regions.

The brown-tail moth appears to be on the increase in the eastern part of the territory, although special efforts were made by the State officials to clean up isolated infestations in the spring of 1919. Unless all colonies of this insect are thoroughly treated it is likely to increase its range.

EXTENSION AND DEMONSTRATION WORK.

This work was instituted under the provisions of the first food-production act and continued during the fiscal year under funds made available to this bureau under the second food-production act. Mr. J. A. Hyslop has been in charge of this work from its institution to its final termination on June 30, when the war activities of the department were closed.

During the past fiscal year 4 additional States entered into project agreements with the Bureau of Entomology, making a total of 37 States cooperating with the bureau in teaching entomology in the

field. An average of 75 specialists from the bureau has been maintained, 109 men having been employed during the year. The apparent increase in the personnel, in spite of its prospective termination at the end of the fiscal year, is due to the large force engaged to spread information and to do survey work in the attempted control of the imported European corn borer and in the extension of the oriental peach moth activities of the bureau.

The policy during the year has been gradually to reduce the personnel and to place this work on a permanent basis in the State extension service. A number of the agents engaged in extension work were transferred to fill vacancies in the research branches of the bureau's activities.

Owing to the success of permanently connecting the field agents with the extension staff of a State, instead of carrying on the work from a regional standpoint as was done last year, the work has been placed in a much better position to be finally absorbed by the State than would have been possible otherwise.

Most of the beekeeping work has been placed upon a definite co-operative basis and financed jointly by the State and the bureau. The balance of the work, however, has been entirely financed by the Federal Government.

The work on control of insects affecting domestic animals was a notable exception to this plan. As there were very few men fitted to do extension work along this line, it was found necessary to have the bureau's agents cover several States during the working season.

During the year 69,000 people were reached. This decrease from last year was largely due to the rapid decrease in the personnel at that time of the year when the most effective extension work can be carried on.

The bureau's representative in this work is cooperating with the States Relations Service by inspecting and criticizing all projects submitted for Smith-Lever fund work along entomological lines.

Another activity of this office has been the work in connection with the bureau's entomological exhibits. This year an exhibit of photographic bromide enlargements illustrating the most important insect and control methods, models of insect-catching devices, spray machines, dusting machines, and other entomological appliances, and cabinets illustrating the more important insecticides were sent to France to be used in connection with the educational work being carried on by the Young Men's Christian Association among the American soldiers.

Competent and instructive exhibits have been prepared, to be shown at the State fairs this year.

SOUTHERN FIELD CROP INSECT INVESTIGATIONS.

The work of this class has been carried on, as before, under the direction of Dr. W. D. Hunter.

POISONING THE COTTON-BOLL WEEVIL.—In last year's report it was shown that one of the most striking achievements of the bureau which culminated during the year was the determination of the great value of powdered lead arsenate or calcium arsenate against the cotton-boll weevil. Large-scale experiments have been continued since that report. The methods and details of procedure of keeping

the boll weevil in check by this method have been improved and thoroughly tested on a large scale. Cotton planters all over the weevil-infested portion of the cotton belt are taking up this method, and hundreds of individual inquiries in regard to it have been answered. The bureau is certain, however, that the exact methods which have been successful under conditions that exist in the Mississippi Delta will not be perfectly applicable to all portions of the cotton belt. Therefore, circulars have been issued regarding the general application and making it plain to planters that methods should be varied according to conditions. The weevil has been more numerous during the summer of 1919 than it was during the previous summer, and planters have therefore been more than ever desirous of trying this remedy. The bureau, therefore, has been especially anxious to guard them from mistakes.

An enlargement of this investigation seems necessary to bring about the best results. Experimental farms should be established in a dozen or more cotton-growing regions, and the very best method for each region must be worked out before planters can apply the remedy with confidence. The commercial results that have been reached already, however, in the delta region assure ultimate results of probably equal value in the other parts of the cotton belt after these comparative studies shall have been made.

OTHER COTTON INSECTS.—At the laboratory at Madison, Fla., a study of the Hemiptera attacking cotton east of the Mississippi River has been completed. At this station also a thorough study has been made of the varieties of sea-island cotton with especial reference to earliness of growth under boll-weevil conditions. Thirty-two varieties have been tested in this work. The importance of early fruiting of sea-island cotton under weevil conditions can not be overestimated. Careful studies at this point have also been made on the relation of the immature stages of the weevil to temperatures. The dry period in Florida, usually commencing about the 20th of May and extending to the 20th of June, seems to retard the weevil to such an extent that the problem of growing upland cotton under weevil conditions is very encouraging.

INSECTS AFFECTING SUGAR CANE.—The best hope for control of the moth borer of sugar cane now seems to be the importation and establishment of parasites which exist in Cuba. Experts were sent to Cuba in the beginning of the fiscal year and again in April, 1919. Parasites have been imported, and every effort is being made to propagate them in the Louisiana cane fields.

TOBACCO INSECTS.—In Florida, promising control of the tobacco flea-beetle has been obtained with certain insecticides—an important result, as in 1918 one grower claimed a loss from this insect of \$650 per acre. Dusting methods in the shade-grown tobacco region have been revolutionized by the introduction of power machines which are capable of dusting from 10 to 20 acres per day more than can be done with hand dusters. For the tobacco thrips it has been found that nicotine sulphate, 14 ounces, and soap, 3 pounds, to 50 gallons of water, gives satisfactory control if applied properly once a week during the emergence period. A very important point is the time of application. Much valuable work has been done on other tobacco insects.

RICE INSECTS.—A Farmers' Bulletin treating of the principal insect enemies of the rice crop in the United States has been prepared for publication.

INSECTS AFFECTING THE HEALTH OF MAN AND ANIMALS.

In cooperation with the National Research Council and the Surgeon General's Office of the War Department, studies on the body louse were actively pursued during the year. This work resulted in the accumulation of much practical information concerning the value of the laundry processes, the dry-cleaning processes, and other means of control. A large number of chemical methods of treatment were also studied, and additional observation on the bionomics of lice was made. Many proprietary louse remedies were carefully tested, in cooperation with the Insecticide and Fungicide Board, thus protecting the Government against expenditures for worthless remedies.

An expert of the bureau has been assigned to work, in cooperation with the Public Health Service, on the problem of the species and habits of flies breeding in human excreta, especially in the open privies in rural communities of hookworm regions. The headquarters of this work are at Wilmington, N. C.

Several of the experts of the bureau were assigned to sanitary work in the Army, especially with relation to the insects that carry disease.

The work on insects affecting domestic animals has been considerably enlarged. Investigations of the biology, distribution, and methods of control of the ox warble were especially taken up, and important facts were gained in regard to biology. The work upon the screw worm was continued, as well as investigations of the horse-flies in eastern California and Nevada. Life histories of three of the more important species have been fairly well worked out. The lice of domestic animals have been studied from the remedial point of view, and methods of applying sodium fluorid to destroy chicken lice and pigeon lice have been perfected. Some supervision of certain packing establishments has been carried on in the effort to reduce the number of flies. This has been a continuation of previous work and is of much importance.

BEE CULTURE INVESTIGATIONS.

This work has continued under the supervision of Dr. E. F. Phillips. It has been chiefly a continuation of the campaign for increasing the honey crop, which was begun as a war measure. The educational activities then begun have been so eagerly received that they can not be discontinued, and it is still important that the enormous loss of ungathered nectar shall be reduced. During the year the apiary and laboratory were moved to a building in Somerset, Md.

DEMONSTRATIONS IN BEE CULTURE.—In addition to funds available under the regular appropriation, \$15,000, available from the food-production act, was used for demonstrations. The work was conducted as one project. As qualified men were found the number of agents was increased until there were in the field 16 men, working in cooperation with the several extension divisions of the 20 States to which they were assigned. Because of the great difficulty of finding competent men, it was possible to maintain an average force of only 12.

The work of these men was an effort to instruct beekeepers in better methods of production and care of their bees, so that the honey crop of the country might be increased. It will be desirable for many years to keep on increasing the production of honey, in order to conserve this natural resource which is now so generally wasted. There was also a great demand for honey for export to the allied countries, and this demand has continued since the cessation of hostilities.

During the fiscal year the field men, assisted from time to time by the regular office force, held over 1,000 meetings, attended by 25,000 beekeepers, and in addition they have visited over 2,500 apiaries and have given personal instruction to the owners regarding their beekeeping practices. The work of organizing the beekeepers into associations has been continued, and in several States these county organizations are being federated with the State beekeepers' organizations. There are now over 300 such county associations of beekeepers. During the year arrangements were made so that every man of the field force is assigned to a single State in cooperation with the extension divisions, both cooperating organizations paying part of the expense.

The meetings held by the field men must be limited in the topics discussed, and it is impossible to cover many important lines of work for lack of time. To overcome this difficulty a trial was made in the holding of extension short courses of a week's duration. The first of these schools was held in California during the year, and these were so successful, in spite of the severe influenza epidemic, that the same plan was later put in operation in New York, Indiana, Iowa, and Minnesota. The average attendance at these schools was about 100 beekeepers, who came for intensive instruction for a period of a week, and the work with these men during these schools leads to a strong belief that more good was done than could have been accomplished in the same time with shorter meetings even with a larger number in attendance. These schools are planned for commercial beekeepers. The instruction was on fundamental problems of the beekeepers, no attention being given to the mere simple mechanical operations, but emphasis was placed on the reasons for various practices as based on the behavior of the bees. In every State where the work was given the beekeepers and extension officials have asked that similar schools be held in the future, and other States have asked for schools.

A bulletin on commercial comb-honey production (Farmers' Bulletin 1039) was issued during the year. It is a revision of Farmers' Bulletin 503. A bulletin on swarm control is in process of preparation, and one on extracted honey production. When these bulletins are issued it is planned to publish a bulletin on beginning beekeeping, and then to discontinue the present general bulletin on beekeeping (Farmers' Bulletin 447) and to replace it with one which will serve to tie together the various technical bulletins on special topics.

WINTERING OF BEES.—Little work has been done during the year on the investigational phases of this problem, because the field men have been necessarily occupied with purely practical work and the office force with answering requests for information sent in by beekeepers, but observations have been continued which fully substantiate the results of the more detailed work. During the year two

bulletins of a practical nature were published—Farmers' Bulletin 1012, on the care of bees when wintered outdoors, and Farmers' Bulletin 1014, on wintering bees in cellars. These bulletins give explicit directions for the care of bees during the winter season and contain recommendations applicable to the entire country. It is gratifying to report that beekeepers throughout the country are paying more attention to the careful wintering of their bees since the bureau took up this subject for investigation.

DISEASES OF BEES.—During the year a paper (Department Bulletin 780) was published on Nosema disease, a malady of adult bees which may at times cause some loss. A bulletin (Farmers' Bulletin 975) was issued on the preventive and remedial measures to be employed against European foulbrood, and in this bulletin for the first time detailed attention is given to the factors which may successfully be used by the beekeeper to prevent the inroads of this disease. Papers on the etiology of American foulbrood and European foulbrood were also prepared, and a paper on the behavior of bees in the cleaning out of European foulbrood, a phase of investigation which had previously been neglected, but one which now promises to yield most important results from the standpoint of control of the disease. An investigation was made of the peculiar manifestations of European foulbrood in California, where, because of the climatic conditions and the character and time of the honey flow, and perhaps especially because of the methods of beekeeping employed, the disease is unusually destructive and shows characteristics not often encountered elsewhere. During the year 563 samples were received from apiary inspectors and from beekeepers for diagnosis.

EFFECT OF THE WAR ON BEEKEEPING.

In the last annual report attention was called to the effects that the war had on the beekeeping industry. The increased demand for honey for export has continued ever since the cessation of hostilities and there is reason to expect that this market will continue to be an important factor in American beekeeping. During the period of severe sugar shortage, the home consumption of honey was greatly increased, but beekeepers were worried for fear that when sugar became plentiful this demand would cease. If beekeepers are able to produce enough honey to meet this increased and increasing demand this enlarged home consumption will continue. The local sales of honey, near the points of production, increased more rapidly than sales in the larger markets, but this can readily be remedied by the further development of the larger bottling trade in honey for which there is demand.

After the winter loss in the white clover region during the winter 1917-18, the beekeepers of this region found themselves short of bees in the spring of 1918, just at a time when there was the greatest opportunity to build up their business. This produced a great demand for bees in combless packages from the Southern States and resulted in the building up of a large business of this character, which will continue and will be an important factor in beekeeping in the future. The supply of bees from the South in 1918 probably did not fully replace the winter loss during the summer of 1918, but because of the increase made by beekeepers there are probably

more bees in the important clover region than ever before. The demand for queenbees to be furnished by professional queen breeders was so great during the spring of 1919 that practically all of them had more orders by May 1 than they could fill during the entire summer. In the West, where the loss of bees was not unusual, there has been even a greater increase in the holdings of the larger beekeepers, resulting in a greater difference between the commercial holdings and the bees in the hands of amateur beekeepers. The tendency to collect the bees of the country in the hands of commercial beekeepers is a most wholesome sign for the proper development of the beekeeping industry for the future, and the war's net result on beekeeping will be an increase in the commercial aspect of the business. The increase of commercial beekeeping has greatly increased the demand for assistance to beekeepers and has made them eager to accept the extension activities of the office. The correspondence of the office is now twice what it was before the entrance of the United States into the war. The demand for beekeepers' supplies and for literature on beekeeping has been greater than ever before in the history of beekeeping in the country.

In explanation of the desirability of making the beekeeping industry one which is in the hands of professional beekeepers rather than to urge the keeping of bees on every farm, it may be stated that the prevalence of the two destructive brood diseases throughout the country, and especially the necessity of careful study of beekeeping problems in order to obtain the maximum crop, make it almost impossible for the person having only a few colonies to give the care to the bees which will result in good beekeeping. Only the man who makes this his chief work may expect to get the returns which are obtained from colonies properly cared for.

GENERAL SUMMARY OF THE WAR ACTIVITIES OF THE BUREAU.

(1) A very perfect system of reporting insect outbreaks was organized, the result of which was a close knowledge of the exact conditions almost from day to day of insect-pest increase over the whole United States. These conditions were made known to all of the economic entomologists of the country through circular letters, and by cooperation based upon this intimate knowledge crop pests were held in check and food production greatly helped.

(2) By conferences with the chemists and the insecticide manufacturers the problem of the reduced quantity of arsenic (on account of its use in munitions) was met, and by conservative use and better distribution the supply was made to cover the needs of the farmers, fruit growers, gardeners, and others.

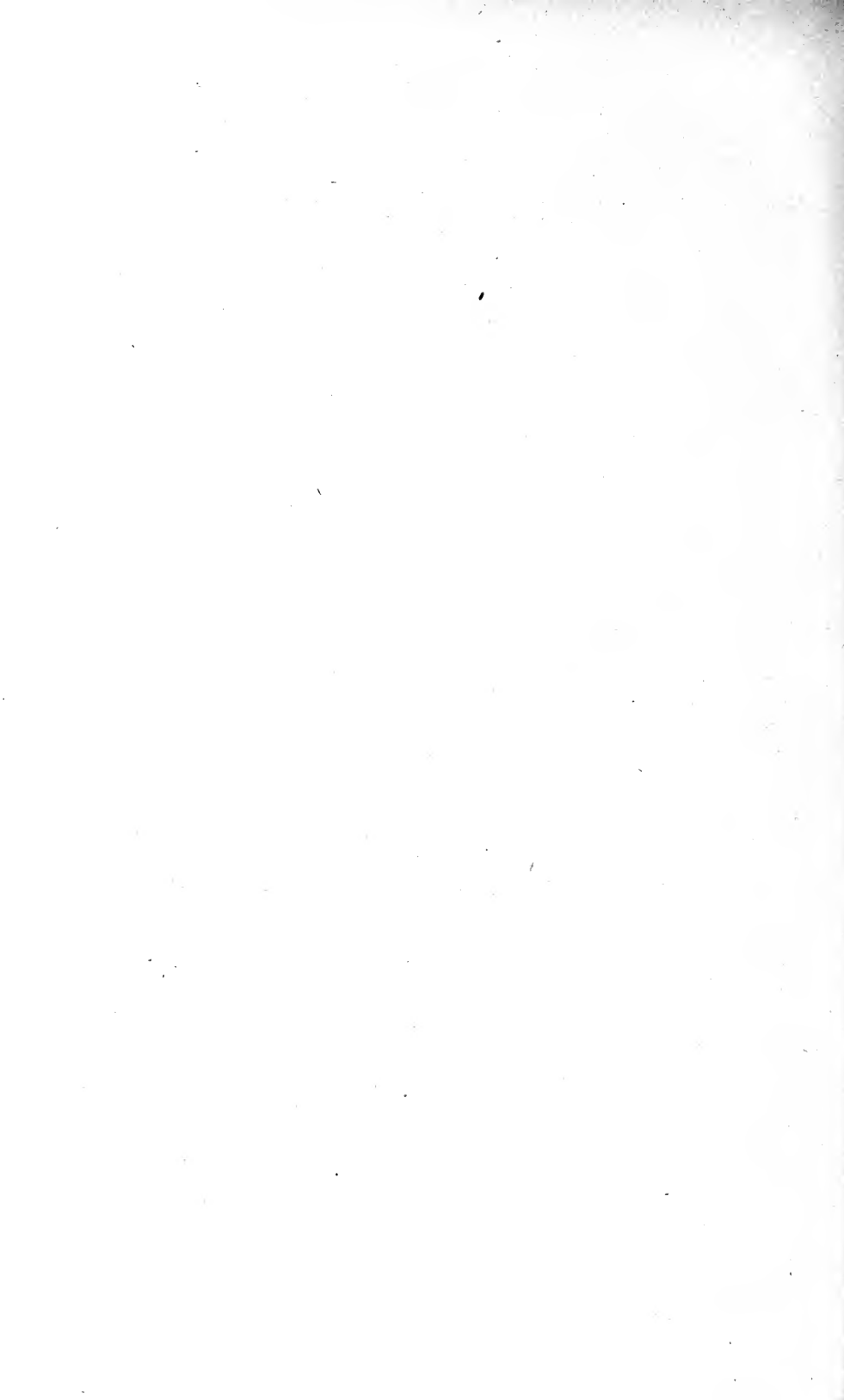
(3) The bureau assisted the Quartermaster General's Department of the Army by inspecting the enormous quantities of grain and other material intended for shipment to Europe and gave advice as to fumigation and other treatment when such stored products were found to be infested with insects. It also inspected warehouses and mills in the same way in many parts of the country.

(4) Advice was given to representatives of the War and Navy Departments and the Shipping Board relative to insect damage to lumber and stored wooden implements.

(5) By the efforts of the beekeeping section of the bureau the beekeepers of the country were aroused to the necessity of a great increase in honey, owing to the shortage of sugar. Specialists were sent out, held meetings, addressed more than 25,000 beekeepers, visited the apiaries, and gave personal instruction, with the result that the honey crop was greatly increased. Our exports of honey to allied countries increased at least ten times over those of any period previous to the war, and the domestic consumption of honey also greatly increased.

(6) In medical entomology the bureau maintained a thorough co-operation with the Office of the Surgeon General of the Army in the matter of experimental work on insect problems. All insect remedies reported to the Medical Department of the Army were referred to the bureau for opinion or for test. The most extensive work was done on the subject of the body louse, and branch laboratories were established for experimental tests. Experts of the bureau were in several cases engaged for special work in concentration camps against insects carrying disease, and at the close of the war one of these experts, who had early entered the Army as a reserve officer, had virtual charge of the great delousing plant at Camp Mills, through which troops returning from Europe were passed.

The foregoing six paragraphs include only the broadest outline of the work which, were it to be stated in more detail, would indicate that in very many directions the bureau's services were most important.



REPORT OF CHIEF OF BUREAU OF BIOLOGICAL SURVEY.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., September 4, 1919.

SIR: I have the honor to submit herewith a report on the work of the Bureau of Biological Survey for the fiscal year ended June 30, 1919.

Respectfully,

E. W. NELSON,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

WORK OF THE BUREAU OF BIOLOGICAL SURVEY.

The activities of the Bureau of Biological Survey are conducted under four divisions: (1) Investigations of the food habits of North American birds and mammals in relation to agriculture, in charge of Dr. A. K. Fisher; (2) biological investigations, with special reference to the habits and geographic distribution of native animals and plants, in charge of E. W. Nelson; (3) supervision of national mammal and bird reservations, in charge of Dr. G. W. Field; (4) administration of the migratory-bird treaty act and enforcement of the Lacey Act regulating the importation of birds and the interstate shipment of game, in charge of George A. Lawyer.

ECONOMIC INVESTIGATIONS.

Largely increased war emergency funds were added to the regular appropriation during this fiscal year for the campaign against predatory animals and injurious rodents. As a result, the work was more thoroughly organized and was conducted on a greater scale than during any previous year. The Federal funds available for this purpose amounted to \$592,000. To this was added a total of more than \$800,000 by States, counties, farmers and stock-growers' organizations, and individuals, in funds expended in cooperation with, and mainly under the direct guidance of, the Biological Survey. In addition to these funds, much material and the personal services of many thousands of farmers and stock growers were contributed to the field work, in assisting to destroy animal pests both on private lands and on Government lands adjacent to private holdings. In North Dakota about 42,000 farmers joined in the work and in Montana about 18,000. In other States cooperation was general and involved large numbers of men.

During the early part of 1919 the legislatures of Arizona, Colorado, Idaho, Nevada, New Mexico, North Dakota, Montana, Oregon,

California, Texas, Utah, and Washington made direct appropriations amounting to \$688,000 to be expended in this work during the two following years in cooperation with the Biological Survey.

Wherever work has been undertaken the rapid growth of cooperative funds and the increase in the number of men participating furnish a practical demonstration of its success and usefulness. The bureau is in constant receipt of urgent requests for additional help far beyond the limits set by its available funds.

Estimates based on information supplied by farmers and stockmen indicate that the destruction of more than 32,000 predatory animals under the direction of the Biological Survey during the year resulted in a saving of live stock valued at approximately \$5,000,000; and the destruction of prairie dogs and other rodents resulted in a saving of enormous quantities of forage, and also of crops valued at not less than \$14,000,000.

PREDATORY ANIMALS AND RABIES.

Of the total funds available for the campaign against injurious animals, about \$375,000 was provided for use in destroying wolves, coyotes, mountain lions, bobcats, and other stock-killing animals and for the suppression of wild animals affected with rabies. For the prosecution of this work, which began in 1915, the Western States have been organized into 10 districts, each with a trained inspector in charge, as follows: (1) Arizona, (2) California-Nevada, (3) Colorado, (4) Idaho, (5) New Mexico, (6) Montana, (7) Oregon-Washington, (8) Texas, (9) Utah, (10) Wyoming-South Dakota.

During the year a force of from 400 to 500 skilled hunters has been employed under the direction of the various inspectors. The salaries of a part of the hunters are paid from the Federal Treasury and of the others from cooperative funds supplied by the States or by contributions from local organizations and individuals. As heretofore, the hunters are not permitted to receive bounties, and the skins taken by each become the property of the Federal Government, the State, or the organization or individual providing the money for salary. Skins taken by Federal hunters during the year netted the Federal Government \$76,128.56, which has been turned into the United States Treasury, making the total received by the Government from this source to date \$197,387.37.

The number of skins or scalps of predatory animals taken by official hunters during the year is as follows: Wolves, 584; coyotes, 27,100; mountain lions, 149; bobcats, 4,123; Canada lynxes, 43; bears, 81. In addition, as a result of poisonous operations, so many dead coyotes are reported by stock growers to have been found on the ranges where poisoning operations were conducted that it is safe to estimate the number destroyed in this way as more than equaling the approximately 32,000 predatory animals of which the skins and scalps were taken.

Predatory-animal hunters are directed to consider bears under ordinary circumstances as game animals and have positive instructions to take every precaution not to kill any except those known to be destructive to live stock. Unfortunately, occasional unoffending bears are taken in traps set for other animals, thus making the number of bears killed during the year considerably larger than would

otherwise be the case. The vast majority of bears are inoffensive so far as injury to stock is concerned, but occasional individuals in all parts of the range country become stock killers, some of them being notoriously cunning and destructive in their activities. Naturally such animals must be eliminated, and the more promptly this is done the less prejudice there is likely to be created among the stock growers against all bears.

From much expert study and experimentation, great improvements in methods of poisoning predatory animals have resulted. Larger and more thoroughly organized poisoning campaigns than ever before attempted were conducted during the year. Their success was such that in many areas stock growers are urging the extension of this method as being the most practicable one for the control of coyotes. Extended poisoning operations were conducted in the great sheep-growing sections in Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming. This was followed by a marked decrease in the number of coyotes in the sections poisoned, with a corresponding decrease in the losses of sheep, cattle, pigs, colts, and poultry. Reports have been received from stockmen stating that on many important ranges and lambing grounds the former heavy annual losses have become negligible or have been entirely eliminated.

For a number of years rabies has been prevalent among predatory animals in California, Idaho, Nevada, Oregon, Washington, and Utah. A part of the money available for predatory-animal control has been appropriated for the specific purpose of destroying the wild animals affected with this disease in the States named. Although the disease still maintains a foothold in all of these States, efforts in suppressing its carriers have been so successful that its spread to other States has been prevented, and the number of domestic animals and persons bitten by rabid wild animals has steadily decreased until at present the number is very small. When an outbreak of the disease occurs in any district, hunters are immediately concentrated there, so that the wild animals carrying the rabies are summarily destroyed and the spread of the disease is promptly stopped.

The serious situation resulting from the outbreak of rabies before it was controlled is indicated by the fact that in the fiscal year 1915-16, when the principal outbreak in Nevada occurred, it was estimated that live stock in that State valued at about \$500,000 were lost through being bitten by rabid animals. Some ranches lost from 200 to 400 head of cattle. Up to the present time approximately 1,500 persons are known to have been bitten by rabid animals and treated for the disease, and at least 47 are known to have died from it. Without Federal intervention for the suppression of rabies, the ravages brought about by it would have been vastly increased. Furthermore, it should be borne in mind that with the disease still persistent in scattered localities throughout the territory where it was once generally prevalent, the removal of organized preventive measures would at once result in its renewal and spread throughout the western range States.

Special efforts are being made by inspectors of the bureau to destroy individual predatory animals which have become notorious for their stock-killing exploits in various States. Near Dubois,

Wyo., a mountain lion was killed in the spring of 1919 which was known to have destroyed \$1,000 worth of live stock last October and to have killed a number of cattle during the winter. This was a much-hunted and battle-scarred animal which had been wounded a number of times by private hunters. Another mountain lion taken in April had killed seven colts during the spring. In the same State a pair of wolves were killed—the female by a Government hunter and the male by a private hunter—which had destroyed more than \$2,500 worth of stock during the preceding year. The owner of a ranch near Mertzon, Tex., reported that in less than three months his losses amounted to nearly 300 sheep, valued at \$3,200, caused by 6 coyotes which one of our hunters captured during July. In western Colorado, in an area about 75 miles in diameter which was poisoned two successive years, through cooperation between local stock growers and the bureau, sheep owners reported formerly a loss of about 25 sheep a day throughout the season, but the destruction of predatory animals has been so thorough that at present the losses are nominal, and sheep are reported to range freely, sometimes unattended for several days in succession, without loss. In New Mexico the wolves, which were estimated to number between 300 and 400 at the time the campaign began there, have been reduced to less than 30 individuals, and this number is being steadily decreased by the persistent campaign against them. These remaining wolves are mainly experienced adults, causing annual losses of live stock amounting to about \$2,000 each. In southern New Mexico the stock of wolves is constantly renewed by stragglers from the mountains of northern Chihuahua. In addition to the ravages from the native predatory animals, live stock in parts of Texas, Arizona, and other States suffer from depredations by dogs which have gone wild and have taken up the predatory life of wolves. In some places the dogs join the wolves, and the half-breed offspring increase the packs.

RODENT CONTROL.

As in the previous fiscal years, the war emergency need for increasing the food output caused the bureau to concentrate its campaign against injurious rodents about farm areas. As heretofore, the effectiveness of this work was greatly increased by the cooperation of the States Relations Service of the Department of Agriculture and of the extension services of State agricultural colleges. The county-agent organization of the latter, in greatly enlarging the educational campaign, brought about a public appreciation of the enormous losses from the depredations of rodents and secured the cooperation of the farmers on a large scale. As a consequence the most vigorous and successful drive yet made was conducted against the myriads of prairie dogs, jack rabbits, field mice, and other rodent pests which seriously decreased the output of grain, alfalfa fields, and orchards and lessened the value of truck and garden crops, as well as of forage on the stock ranges throughout the West.

Cooperative campaigns with local organizations and individuals were conducted in Arizona, California, Colorado, Georgia, Idaho, Kansas, Maryland, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and

Wyoming. Preliminary conferences were held in reference to the organization of similar work in Iowa, Minnesota, and Texas. Investigations for bettering the methods of destroying injurious rodents as well as improving the organization are being conducted, and the work is becoming increasingly effective.

Field investigations through inclosed trial plots for the purpose of securing accurate data as to the destruction of forage by rodents on the open range have been continued during the year in cooperation with the Forest Service, the State University of Arizona, and the Carnegie Institution of Washington. Interesting and valuable results are being secured.

The demands from the States for increased activities in rodent-control work, and the money offered by States and counties for cooperative purposes, are far greater than the bureau can possibly meet with its available funds. The opportunity for useful expansion in this work is obvious in view of the fact that native rodents destroy each year field crops and forage worth approximately \$300,000,000, while the losses from house rats and mice approximate nearly \$200,000,000, a large proportion of which can be eliminated at moderate cost.

Through a system of contracts the bureau has been able to assist the States in securing poison supplies for use in rodent campaigns at a discount amounting to many thousands of dollars, thus increasing the effective use of their funds.

PRAIRIE DOGS.

Prairie dogs occupy more than 100,000,000 acres of public and private lands. Wherever they occur in abundance they are exceedingly destructive to cultivated crops and to forage on the open range. In cooperation with the extension services of the agricultural colleges in Arizona, Colorado, Montana, New Mexico, North Dakota, Oklahoma, South Dakota, Utah, and Wyoming, the campaign against these animals has been pushed aggressively. In Arizona and New Mexico the State councils of defense joined actively in the work and contributed funds for the purpose. The participation of farmers and stockmen has been fuller than ever before, and the saving of crops and forage has been correspondingly great. During the year from 75 to 95 per cent of the prairie dogs were destroyed on nearly 2,000,000 acres of privately owned crop and forage lands and on more than 200,000 acres of public domain, the latter making more than 3,700,000 acres of public lands which have been largely freed from these pests. In many places private landowners were so interested that they volunteered their services to clear adjacent Government lands, the bureau supplying the poison to be used in the work. With cooperation of this character it will be possible to clear large areas of the public domain at almost a nominal cost to the Government.

GROUND SQUIRRELS.

Numerous species of ground squirrels occur in the West, several of them having such wide ranges and existing in such abundance that their depredations on crops and forage are most serious. As with the prairie dogs, continued investigations are being made to devise improved methods of poisoning and of organization for their destruction. The poisoned grain used for operations against ground squirrels on private lands is prepared under the supervision of field

representatives of the bureau and furnished cooperating farmers at cost through local organizations. In this way 1,349 tons of poisoned grain were prepared and distributed during the year, and nearly 110,000 farmers took part in the campaign.

Through the plan inaugurated by the bureau of cooperative purchase of poison supplies the saving in the squirrel campaign, as well as in the destruction of other rodents, has been very great, as illustrated in Idaho, where it amounted to about \$18,500.

During the year ground squirrels were poisoned and mostly destroyed on more than 1,294,000 acres of public domain and on more than 13,465,000 acres of private lands. This resulted in materially increasing the percentage of crops harvested in all the States where work was conducted and in increasing the forage output on the public domain.

JACK RABBITS AND COTTONTAILS.

As in previous years, work was done to control the losses of crops, including wheat, barley, oats, beans, alfalfa, and others, from jack rabbits, particularly in Arizona, Idaho, Nevada, New Mexico, Oregon, Utah, and Washington. Wherever market and other conditions were favorable, jack rabbits were killed by drives and by trapping in order that they might be sold for food. In this way two counties in Utah, under the direction of a representative of the bureau, marketed 6,500 of these animals, besides the large numbers marketed independently. Effort is being made to develop the utilization of the meat and skins of these animals through standardized methods of dressing and marketing. In many places where it was impracticable to kill jack rabbits for market purposes extended poisoning operations were conducted, as in Idaho, where in this way 40,000 of these animals were killed in one county.

In addition to damage by jack rabbits, complaints have been received by the bureau of depredations by cottontails among fruit trees, and in truck and other agricultural crops. Complaints of losses from this source have been more numerous from the Eastern States, where demonstrations have been given to teach farmers the most practicable means of protecting their crops from these animals.

POCKET GOPHERS.

Pocket gophers are exceedingly injurious to root crops, peanuts, beans, alfalfa, hay meadows, grazing lands, and orchards. The seriousness of their depredations is indicated by an estimate made by a competent official of the Kansas Agricultural College that during 1918 they destroyed one-tenth of the alfalfa crop in that State. The alfalfa crop of Kansas for that year was valued at \$50,000,000, so that the damage by pocket gophers to this crop alone amounted to about \$5,000,000. In view of the fact that these animals also do extensive damage to orchard and other crops, the injurious character of this pest is evident. Pocket gophers have a wide distribution in practically all of the States from the Mississippi River to the Pacific coast. On some of the most productive grazing lands on the national forests they seriously reduce the forage production. Methods of destroying these animals adapted to use in extensive community campaigns have been much improved during the year.

Pocket gophers not only damage established crops, but frequently interfere with the introduction of new and valuable crops. This was

well illustrated at Hearne, Tex., where the quarantine against the pink cotton boll worm prevented the growing of cotton. The State agricultural college planned to foster the planting of peanuts as an important food and feed crop, but this was found to be impracticable on account of the abundance of pocket gophers. At the request of the agricultural college, an experienced representative of the Biological Survey was detailed to assist in organizing a community campaign against these animals. Farmers and business men joined heartily in the work, with the result that every pocket gopher in the area treated was reported killed, and an excellent crop of peanuts was planted and harvested.

MOUNTAIN BEAVERS AND WOODCHUCKS.

The investigations were continued into the habits of the mountain beaver, or sewellel, a curious rodent living in the humid region of the Northwest coast. With the development of agriculture in its region this animal, which was formerly considered harmless, has become increasingly injurious to crops, particularly to small fruits and to market produce. Methods for its control have been devised, and demonstrations were made by a representative of the bureau in various localities in Washington and Oregon where there was need for the adoption of active measures.

Woodchucks have continued to be a source of annoyance and loss to gardeners and truck growers throughout the northern and northwestern sections of the country. In many parts of the Northwest the planting of alfalfa and clover and of other succulent crops has attracted the attention of woodchucks, which have concentrated about these new sources of food supply, with attendant losses to the farmer. In some of the Northwestern States where the woodchucks live in the rocks adjacent to cultivated fields, strips of alfalfa and clover several hundred feet wide along the borders are often completely destroyed. It was found that the methods of destroying these animals used successfully in places where they live in burrows in the open country were not effective in this region. Successful methods were here developed, however, and as many as 55 woodchucks have been killed in a single field demonstration.

NATIVE MICE, WOOD RATS, AND COTTON RATS.

Widespread damage to orchards by the depredations of native mice continue to be reported, the most conspicuous occurring in the States of Virginia and Washington. In Winchester County, Va., the loss is reported of more than \$200,000 by pine mice, which gnaw the bark from the roots of orchard trees. Demonstrations have been given for the control of these pests.

In Florida surprisingly successful experimental plantings of sugar cane on a considerable scale have been made within the last two years, but during the year reports have been received of extensive damage to the cane by rodents which destroy the seed cane and cut the growing stalks. So serious has been this damage that the principal company interested in the development of the sugar-cane industry in that State has written the bureau that unless some method can be found for successfully controlling the cane-destroying rodents the development of the industry there will be

impossible. Losses of from 40 to 60 per cent of the growing cane have been reported. The depredations are by the cotton rat, a small ratlike rodent limited to the South Atlantic and Gulf States. Investigation has determined effective methods of poisoning these rodents, and it is believed that through demonstrations and advice the growers will be able to control the rats and reduce the losses to a negligible amount.

Wood rats continue to be troublesome in limited areas, and where they become especially injurious demonstrations and advice have been given for their control.

HOUSE RATS AND MICE.

The extended educational campaign inaugurated last year was continued in order to acquaint the public with the serious drain on the Nation's food resources through depredations of house rats. Demonstrations were given of methods of poisoning and trapping the animals, and plans for community organization against them were presented and discussed. As a result many State officials, State councils of defense, and public-spirited citizens took up the work of organizing campaigns, and great numbers of the rodents were destroyed.

Requests were made by military and naval officers in charge of camps, arsenals, and storage warehouses in this country for advice and assistance in controlling house rats in the buildings under their control. Experienced representatives were detailed to investigate conditions and recommend plans for limiting the losses. Gratifying results were obtained, perhaps the most important of which was at the Bush Terminal warehouses in Brooklyn, N. Y. These great warehouses were taken over by the Government for Army quartermaster storerooms, and were so badly infested by rats as seriously to endanger the stored food and other Army supplies. At the request of the quartermaster officer in charge, a representative of the bureau made a survey of the warehouses in January, 1918, and recommended a method of procedure for controlling the rats. At the end of the year the quartermaster officer in charge advised that the recommendations of the bureau had been followed with complete success. He reported that at first practically a barrelful of rats were killed each day, and that more than 35,000 rats were killed during the year. The work of destruction was so thorough that he reports the losses of military supplies during the entire year to have been negligible.

Large numbers of the Farmers' Bulletin (No. 896) giving information concerning the destruction of rats were used in this country by the Quartermaster Department of the Army and also in France in an effort to control losses from these animals.

In this connection it may be stated that several experts in rodent control who were commissioned in the Sanitary Corps of the American Expeditionary Forces in France for the purpose of controlling the depredations of rats in connection with the Army operations, were highly successful in preventing heavy losses of quartermaster stores from these rodents.

MOLES.

Throughout the year demonstrations were continued in Washington and Oregon for the control of the large moles which are a serious

pest to agriculture in that region. The fur value of these animals having been established among fur dealers through the efforts of the Biological Survey, the price of their skins continues to advance. In cooperation with extension services and other agricultural agencies in their territory, demonstrations of methods for capturing the animals and preparing their pelts for market were continued. Successful boys' and girls' clubs were organized to trap them and to cooperate in selling the skins. As a result the members of the clubs learned a valuable lesson in cooperative work, not only in ridding fields of a pest, but also in marketing, the sale of the skins netting them the substantial sum of more than \$50,000.

DOMESTIC RABBITS.

The high cost of meat during the war and the scarcity of rabbit skins for manufacturing felt hats and cheap grades of furs combined in emphasizing the opportunity in this country for the profitable production of rabbits. In Europe the growing of domestic rabbits has long been an industry of considerable importance conducted on a small scale by numberless individuals, and it has already been abundantly proved that domestic rabbits do equally well in the United States. Not only is their meat of excellent quality, but their fur is of value also; recently these furs have been manufactured on a considerable scale, dyed and in their natural colors, and are frequently most attractive in appearance.

Under ordinary conditions the rearing of domestic rabbits will give a quick and economical supply of meat, one that can be produced cheaper than that of the domestic fowl; while the skins of selected stock are of sufficient value to render them an important part of the returns. A growing interest has been shown in the bulletins and other publicity from this bureau designed to encourage the growing of these animals on farms and in back yards. National and State rabbit breeders' associations are now well established; clubs and associations are being organized and periodicals developed to increase rabbit growing; and many boys' and girls' clubs have taken up the enterprise. It is believed that through these methods a great increase in the development of this young industry may be brought about.

With a view to fostering the production of these animals along practical lines investigations have been continued among the breeders of the country and among those dealing in the skins and manufacturing the furs. An article on rabbit growing to supplement the meat supply was published in the Yearbook of the Department for 1918, and a bulletin is now in process of preparation to supersede the Farmers' Bulletin (No. 496) on "Raising Belgian Hares and Other Rabbits."

FUR-BEARING ANIMALS.

Investigations concerning fur-bearing animals have been continued and the annual bulletin on laws relating to these animals was issued. The animals now held at the experimental fur farm in Essex County, N. Y., include minks, martens, fishers, skunks, raccoons, and rabbits. Experiments in inclosures for these animals, as well as in feeding and breeding them, and investigations concerning the parasites and diseases to which they are subject, are in progress.

Two graded Saanen goats have been furnished by the Bureau of Animal Industry for use at the farm to provide milk for feeding the fur animals and to keep down weeds in the animal yards. Domestic rabbits are also being grown at the farm in order to supply the fur bearers, especially the breeding females, with fresh meat. The keeping of a few domestic animals at the fur farm has necessitated a limited amount of farming there to produce feed in the form of hay, oats, buckwheat, corn, carrots, and turnips. A building to shelter the rabbits and goats and to store feed for them has been completed during the year, and ground has been cleared and material assembled to build yards to accommodate four pairs of cross foxes.

An inquiry concerning the supply of furs from wild fur-bearing animals has been addressed to a large number of raw-fur dealers throughout the United States, including Alaska. This has developed the fact that there has been an alarming reduction in the number of skins coming to the market during the last decade, and that there is a general demand for short open seasons on fur-bearing animals, and particularly for better enforcement of State laws against trapping fur-bearing animals when their fur is not prime.

Most States now have laws protecting fur bearers during at least a part of the year. Up to within a recent time most of the fur bearers, including such species as the skunk and the mink, have been considered pests, because they at times raid chicken coops. The apparently infrequent damage done by these animals is negligible as against their great value. The skunk feeds largely on field mice and insects and has become one of our most valuable fur bearers. The Commissioner of Conservation of New York reports that during 1918 skunk skins taken in that State brought more than \$1,000,000 in the fur market. There is no State in the country which can not greatly increase the natural resources represented by its fur-bearing animals by proper protective laws and their enforcement.

ECONOMIC ORNITHOLOGY.

Article VII of the migratory-bird treaty between Great Britain and the United States reads as follows:

Permits to kill any of the above-named birds which, under extraordinary conditions, may become seriously injurious to the agricultural or other interests in any particular community, may be issued by the proper authorities of the High Contracting Powers under suitable regulations prescribed therefor by them, respectively, but such permits shall lapse, or may be canceled at any time when, in the opinion of said authorities, the particular exigency has passed, and no birds killed under this article shall be shipped, sold, or offered for sale.

The administration of the act of enforcing the treaty as a consequence of this article has caused a notable increase in the demand for economic ornithological work. Numerous reports of bird depredations have been made, and in some of the cases investigated recommendations for the control of the species have been made, while in others the complaints proved to be without basis to warrant action. The incentive for large crop production incident to the war has been an added cause for the receipt of more than the ordinary number of complaints concerning bird depredations. A policy of bird conservation that will best serve the interests of the farmer involves not only a thorough appreciation of the value of beneficial species, but adequate attention to the control of troublesome ones. Consequently,

now that the beneficial species are fortified by ample protective legislation, the importance of perfecting methods for protecting crops against damage by birds becomes apparent.

FISH-EATING BIRDS.

Continuing the work started last year in investigating the food habits of fish-eating birds, field work was conducted in Florida to ascertain the relation of pelicans to the fishing industry. Claims had been made that these birds were responsible for the reduction in the numbers of mullet noted in recent years, as well as for the destruction of other food fishes. It naturally followed that the protection of the brown pelican in the breeding colonies, which are maintained as bird reservations, was criticized. The habit of young pelicans, in common with some of the other fish eaters, of regurgitating their food when disturbed, permitted the examination of the stomach contents of several hundred of them without killing a bird. Of the 814 fish found in the material examined only 9 (7 mullet and 2 red fish) were of species valuable as human food. By far the largest item, comprising over 91 per cent of the food, consisted of menhaden, a nonfood fish occurring in great abundance in the shallow waters about Florida and along the Gulf coast. Adult pelicans, however, are at times a nuisance about gill nets, where, in their attempts to secure the enmeshed fish, they tear the seines.

Reports of destruction of trout by mergansers, or fish ducks, in Michigan were investigated, but the mildness of the past winter presented conditions tending to keep these birds out of the smaller streams where the damage is usually done. This matter must be investigated under more nearly normal winter conditions to determine accurately the amount of loss from this source. A report on the economic status of all our fish-eating birds is nearly ready for publication.

NIGHT HERONS IN LOUISIANA.

In Louisiana the night herons had been charged with being a menace to the frogging industry, and for that reason permission was asked to shoot them, as had been done prior to the enactment of the migratory-bird treaty act. Louisiana is the only State wherein night herons had ever been widely considered as legitimate game and a source of food. Among the French-speaking people of some sections the young of these birds are considered a great delicacy, and "gros-bec" hunting has been a favorite sport in the cypress swamps of La Fourche, Terrebonne, St. Marys, and neighboring parishes. An expert made a careful study of the birds in their haunts and after examination of a large number of stomachs reported that these birds are in no way a detriment to the frogging industry. It was proved that more than 96 per cent of the food in the stomachs of the night herons examined consisted of crawfish, and not a single frog was found. These birds were mainly the yellow-crowned species (*Nyctanassa violacea*), but previous examinations of stomachs of the black-crowned night herons showed that they had similar habits.

WHITE-WINGED DOVES IN ARIZONA.

Complaints by grain raisers of Arizona against the white-winged dove also necessitated investigation, chiefly in Maricopa County, where about 30,000 acres of wheat and barley had been planted. It

was found that the doves were very abundant and that by far the greater part of their food was secured from the waste grain dropped among the stubble. The birds seemed to prefer feeding there even though shocks or stacks of grain remained in the same field. In small fields, especially those located near large breeding or roosting colonies, the damage is sometimes very serious. In such situations it will probably be necessary to permit the killing of birds actually damaging crops.

BLACKBIRDS IN OHIO.

A study of the food habits of red-winged blackbirds in north-eastern Ohio, where sweet corn is grown extensively, determined the fact that these birds are a menace to the crop. The damage is of a most annoying character, as the attacks are made when the crop is nearly ready to harvest. The birds tear open the husks and feed on the terminal kernels, thus making the corn unsalable. Field corn also is similarly damaged. Effective control measures were devised for fields of small size and for garden patches, but for large areas more economical measures must yet be discovered. It has been found that with care and with proper baits strychnine may be used against blackbirds with very little danger to other wild or domestic bird life.

BOBOLINKS, OR "RICE BIRDS," AND THE RICE CROP.

A complaint coming from the lower Delaware Valley regarding depredations by bobolinks, "reedbirds," or "rice birds," was investigated and found to be without foundation, but a continuation of this investigation in the South Atlantic States indicated that these birds are as destructive to rice as ever wherever opportunity offers. On their northward migration they do great damage to newly-sprouted rice and on their southward journey they raise havoc with rice in the milk. Untold thousands of these birds swarm in dense clouds over rice fields, where they may ruin the crop in a few hours. It was found that the losses to rice growers from these birds in the fall of 1918 amounted to about \$150,000. In consequence of this an open season on bobolinks has been declared, which will have a tendency toward breaking up large flocks and reducing their numbers. In New Jersey, Pennsylvania, Delaware, Maryland, and the District of Columbia these birds may be shot from September 1 to October 30, inclusive, and in Virginia, North Carolina, South Carolina, Georgia, and Florida from August 16 to November 15, inclusive.

DAMAGE TO RICE BY WILD FOWL.

In the fall of 1917 many complaints were received of damage by wild ducks to the rice crop of the Sacramento Valley, Calif. Investigation was begun by an expert of the bureau as soon as the rice began to head the following August and continued until the harvest was well under way in October. Rice in this region is grown largely on low-lying and more or less alkaline lands unsuited for other forms of cultivation and therefore previously unutilized for agriculture. Considerable numbers of pintails and mallards breed in the marsh and slough areas, and late in summer many other birds congregate there, attracted by the water and food. On moonlight nights pintails come to the rice fields in large flocks to feed. Experiments were made with various means of driving out the birds. It was found that arming men with guns and stationing them in the fields

was one of the best methods, supplemented by occasional aerial bombs that exploded among the birds and frightened them as they rose from the rice. As these ducks are protected under the migratory-bird treaty act, a special order was necessary granting permission to rice growers to kill them before the opening of the hunting season on October 16; after that date rice growers were permitted to shoot at night in fields still containing rice. These measures resulted in a saving of not less than \$125,000 worth of grain, while the number of ducks destroyed was nominal.

In November investigation was made of conditions in the rice district of Arkansas. Owing to unfavorable fall weather, probably two-thirds of the rice crop was unharvested as late as November 25. Migratory ducks, mainly mallards, were then arriving from the north and threatening serious damage. While the hunting season had opened, it was necessary to guard the fields at night, so that a special order had to be made under the migratory-bird treaty-act regulations, allowing rice growers to kill ducks at night.

MEADOWLARKS AND SPROUTING CORN.

The relation of the meadowlark to sprouting grain was a subject of field study in South Carolina. Reports received from most of the South Atlantic and Gulf States indicated that the food habits of the bird in the South were quite different from those it possesses in the North and that it was inflicting severe damage on sprouting corn. During March and April it was found that migrating flocks of these birds were spending a large part of their time in cornfields, feeding on the sweet germinating kernels, secured either by pulling up the sprouts or by making conical borings down to the grain. To afford farmers proper relief permission will have to be given them in certain areas to drive the birds from the fields with shotguns if necessary.

Similar complaints against mourning doves were not substantiated.

DESTRUCTIVENESS OF EAGLES.

From year to year definite and authentic reports are being received on the destruction of young fawns and wild turkeys, and even of young calves in some parts of the West, by golden eagles. Similar reports of the habits of both the golden and the bald eagle in relation to game come from Alaska. It is evident that these powerful birds are seriously destructive at times and their unlimited protection is probably not warranted.

IMMUNITY OF QUAIL AND GROUSE TO STRYCHNINE POISONING.

Important evidence has been secured regarding the comparative immunity of quail to strychnine poisoning. Field observations and feeding experiments conducted in California showed that one valley quail can eat grain containing enough strychnine to kill 12 ground squirrels without showing the slightest ill effect from the poison. A number of similar experiments on a mountain quail and a bob-white gave like results. The information thus gained will tend to allay fears in certain quarters that poisoning campaigns against ground squirrels result disastrously to these valuable game birds. Investigations in Saskatchewan, Canada, have proved that grouse are equally immune to strychnine poisoning.

FOOD HABITS OF OTHER BIRDS.

With a view to ascertaining the food habits of the vireos, examination of stomach contents has been continued and completed for all but one species; similar work has been started on the English sparrow, that its relation to constantly changing agricultural conditions may be known; and examination of the food of other species has progressed so far as a limited force permitted.

During the year two department bulletins were published, *Attracting Birds to Public and Semipublic Reservations*, and *Food Habits of the Mallard Ducks of the United States*, and several *Farmers' Bulletins* were revised. A report has been prepared on the food of winter-bird visitants, including the pine and evening grosbeaks, white-winged and red crossbills, hoary and common redpolls, pine siskin, snow bunting, the various longspurs, and the pipits. Another has also been prepared on the food of shoal-water ducks, dealing with the gadwall, baldpate, green-winged, blue-winged, and cinnamon teals, pintail, and wood duck. For educational purposes a lecture with lantern slides has been prepared on the value of birds to agriculture.

BIOLOGICAL INVESTIGATIONS.

The work of the Division of Biological Investigations has been seriously decreased, owing to the war. Two members of the scientific staff were commissioned in the Sanitary Corps and were in charge of rat-control work in France to safeguard Army supplies, and others were detailed to certain phases of urgently needed economic work.

As has been the case during past years, the field and laboratory work of the division has been conducted along broad lines helpful to the various other activities of the bureau. These activities include the enforcement of the migratory-bird treaty act; enforcement of the Lacey Act regulating importations of, and interstate commerce in, birds and mammals; the administration of the mammal and bird reservations; general conservation of game birds and mammals; and work relating to the economic relations of mammals and birds to agriculture, forestry, and stock-raising.

The card indexes covering the distribution, abundance, and habits of all the species of North American mammals and birds have been greatly augmented during the year. These files contain data from many sources, including reports by field parties of the bureau, notes gleaned from correspondence and other outside sources, and records from publications.

DISTRIBUTION AND MIGRATION OF BIRDS.

Owing to war conditions fewer volunteer observers than usual reported on bird migration. However, 250 observers sent in reports from points throughout the United States and from many localities in Canada and Alaska. Considerable progress was made in compiling information from various publications on the distribution and migration of birds, adding materially to the files, which now contain more than 1,350,000 cards. This source of information is consulted daily in connection with the administration of the migratory-bird treaty act and the investigations of the economic habits of birds.

BIRD COUNTS.

Reports of the fifth annual series of counts of birds breeding on selected areas in various parts of the United States were received from 84 persons, who reported on over 100 different areas. Many of these counts, made on areas previously reported on, showed an increase in bird population. Owing to the unusual conditions throughout the country, on account of the war, many persons who had formerly taken part in the annual bird counts were unable to find time for this extra duty. With the gradual return of normal conditions, however, it is confidently expected that a large increase will occur in the number of these volunteer observers.

BIOLOGICAL SURVEYS OF THE STATES.

Good progress was made in the field work in Arizona, Florida, Montana, Washington, and Wisconsin, continuing the biological surveys which have been in progress during the past few years.

The "Mammals of Panama," one of the results of a cooperative biological survey of the Canal Zone in 1911-12, is about to be issued by the Smithsonian Institution. Works completed, but not published, include List of Mammals of New Mexico, The Mammals of North Dakota, The Mammals of Wyoming, The Birds of Texas, The Birds of Alabama, and The Birds of New Mexico. Negotiations are being conducted for the publication of the last three mentioned by the States to which the reports relate, and those on Alabama and New Mexico will probably be issued within a few months. A systematic study of the rice rats of North America was issued during the year.

BREEDING GROUNDS OF MIGRATORY WILD FOWL.

An investigation of the breeding areas of ducks in North Dakota, begun in June, 1918, was continued during July. During June, 1919, the breeding grounds of ducks and other wild fowl in central Nebraska were investigated in order to compare the results with those found to obtain during former years. A gratifying increase of breeding waterfowl is evident in these States owing to the protection they have in spring under the migratory-bird treaty act.

WILD LIFE IN NATIONAL PARKS.

In cooperation with the National Park Service, Department of the Interior, investigations of the distribution, abundance, and habits of birds and mammals of Yellowstone and Glacier National Parks have been conducted during the past few years. During the fiscal year just closed revised reports on the birds and mammals of these two areas were published by the National Park Service in their educational literature; an elaborate report on Glacier National Park, comprising annotated lists of all the birds and mammals known to occur there, was completed during the year and was published by the National Park Service. A similar report on the mammals of the Yellowstone National Park has been prepared.

RELATION OF RODENTS TO FORAGE PRODUCTION.

In the spring of 1918 field investigations to secure information concerning the damage to crops and forage by injurious rodents were begun in several western States. By means of fenced and unfenced

quadrats established on grazing areas where rodents abounded, studies of the damage inflicted by these pests were instituted. During the spring of 1919 a careful examination of these special areas was made and substantial progress in the elucidation of these problems has been effected. New quadrats were also installed. The results of this investigation will have great practical value in relation to forage on the western range lands.

MAMMAL AND BIRD RESERVATIONS.

The Federal big game and bird reservations in charge of this bureau, remain, as heretofore, 74 in number. Four are big game reservations; one, the Niobrara, created as a bird reservation, is used for both birds and big game; and 69 are bird reservations.

On June 30, 1918, the big game reservations contained a total of 368 bison, 274 elk, 54 antelope, and 21 deer, an increase in each species over the number reported last year.

The Government's seventh bison herd was established at Sullys Hill by the gift of the Park Commissioners of Portland, Oreg., of a nucleus herd of 6 animals. The Government's bison herds now aggregate about 950 head. Losses of antelope have been checked at the Wind Cave Reservation, S. Dak., and at the National Bison Range, Mont.

The number of visitors to the large game reservations is increasing, notably at Sullys Hill, Wind Cave, and at the National Bison Range. Trains on the new branch of the Northern Pacific Railroad from Dixon to Polson, Mont., now stop at Moiese close to the entrance to the main gate of the National Bison Range.

On the Gulf reservations arrangements were completed, as required by law (39 Stat., 1106), for assuming the full costs of warden service, formerly paid in part by the National Association of Audubon Societies. It became necessary also to purchase and maintain a patrol motor boat at Big Lake Reservation, a service formerly provided by the Arkansas Fish and Game Commission.

Under the protection of the wardens, the useful birds on all the big game reservations have notably increased, but particularly on the National Bison Range and the Winter Elk Refuge, incidental to the protection of these reservations for mammals.

MAMMAL RESERVATIONS.

WINTER ELK REFUGE, JACKSON, WYO.—The main purpose of this reservation, which now has an inclosed area of 2,760 acres, is to increase the forage for elk by a limited amount of cultivation. The first cutting of hay is stacked and fed to the elk when there is no available pasturage, and the remainder is left to be grazed by these animals. Besides the hay raised, 2,103 bushels of oats were harvested from 56 acres, incidental to preparing ground for alfalfa. In the spring this area was disked and seeded, and in addition 140 acres having an inferior stand of alfalfa were dragged and reseeded to increase the yield of hay.

At the beginning of the year the hay on hand totaled 755 tons, 120 of which was cut in 1917 and 635 in 1918. Because of the light snowfall over the entire region, the maximum number of elk coming down

at any one time to the refuge to be fed in the spring of 1919 was 3,000, as compared with a maximum of 10,000 for 1918. During 23 days of March (5th to 27th) 164 tons were fed to the elk, leaving a good supply on hand to supplement the harvest of this year. Some hay also was furnished by the State of Wyoming, and 25 tons of oat straw were fed to the elk.

No deaths from starvation were reported. A shortage of feed seems imminent for the coming winter, however, by reason of a severe drought. The drought has had the effect also of concentrating the ground squirrels around the irrigated areas, and as a result it has been possible to poison large numbers of them and thereby decrease their destruction of forage.

During the year somewhat more than 4 miles of new fencing was completed. The feeding corral built last year operated successfully and permitted segregating the young and weaker elk, thus protecting them from the main herd until they were fit to join it. Two cow moose visited the refuge on April 2.

The necessity for increased and definitely provided pasturage is immediate and imperative in order to deal justly with the settlers and to safeguard the existence of the elk. The precarious conditions surrounding the only two remaining large elk herds in the United States and a program for their conservation and for the action necessary to make them of the greatest value to the people are set forth in a department circular (No. 51), *Our National Elk Herds*, published in June in cooperation with the Forest Service.

NATIONAL BISON RANGE, MOIESE (NEAR DIXON), MONT.—The inclosed area of this reservation totals 18,521 acres. It is stocked with the following: Bison, 290 head (including 48 calves); elk, 125 (not including young; antelope 33 (not including young); and mule deer, 13 (not including young). Of the bison, one crippled bull died, and one young calf was killed by an accident.

Serious forest fires threatened the range in August and again in May. Seven hundred acres of young pines and spruces were destroyed, but the fires were checked through the cooperation of the Indian and the Reclamation Services. Several incipient blazes were handled by the warden and assistants without serious loss.

Receiving basins 10 feet to 30 feet in diameter have been scooped out for conserving the water from the springs and making it accessible to the animals.

When the antelope "banded up" in the autumn the count disclosed but 32 as compared with 34 last year, probably the result of unlawful poaching in a remote part of the range. One doe was added by gift of the Oregon Game Commission.

WIND CAVE NATIONAL GAME PRESERVE, S. DAK.—In the 4,160 acres inclosed on this reservation, the big-game animals number as follows: Bison, 52 (including 12 calves); elk, 85 (not including calves); and antelope, 21 (including 7 young).

Thirteen coyotes (two of which were inside the inclosure) and seven bobcats have been killed this year. The scanty water supply has been increased by the development of the Ottman well.

SULLYS HILL GAME PRESERVE, N. DAK.—About 700 acres of this reservation are now inclosed and contain the following: Bison, newly

established, 7 (including 1 calf); elk, 22 (not including calves); and deer, 6 (not including fawns).

NIORRARA RESERVATION, VALENTINE, NEBR.—The big-game animals are at present held in two inclosures of about 200 acres each. The remainder of the reservation, about 4,500 acres north and about 9,000 acres south of the Niobrara River, is being inclosed in a stock-proof fence. The reservation is stocked with the following: Bison, 19 (not including calves); elk, 42 (not including calves); white-tailed deer, 2; Canada geese, 8. Pinnated and sharp-tailed grouse and other useful ground-nesting birds are increasing in numbers.

Two abandoned military structures are being salvaged for use in repairs of other buildings, and arrangements are being made for disposal under condemnation proceedings of the old "Administration Building."

A wire suspension footbridge has been built across the river, one dam constructed, and water from one spring conserved. By special efforts the prairie dogs were greatly reduced, possibly extirpated, thus saving considerable pasturage for the bison and elk.

BIRD RESERVATIONS.

On 10 of the 69 bird reservations, paid warden service has been maintained throughout the year, permanent warden service having been established at the Belle Fourche, S. Dak.; Big Lake, Ark.; and Strawberry Valley, Utah, reservations. At 8 other reservations part-time warden service is maintained during the nesting periods, the hunting season, or at times when serious trespass is likely to occur. Through the cooperation of the Reclamation Service, a general measure of protection is provided on most of the 19 bird reservations located within reclamation projects.

At the Minidoka Reservation, Idaho, a beginning has been made of making two islands of from 100 to 300 acres each, more attractive nesting and feeding places for useful birds, and important species of aquatic plants useful for food for waterfowl have been introduced into Lake Walcott. Certain projected and necessary improvements could not be carried out on account of labor shortage.

At the Belle Fourche Reservation, S. Dak., permanent warden service has been provided, warden's quarters have been constructed, and a large area suitable for nesting and feeding places for wild ducks has been protected by fencing.

At the Big Lake Reservation, Ark., substantial progress has been made in locating, straightening, and defining the boundaries. Reports from various outside sources indicate that the reservation is now serving the purpose for which it was established.

At Deer Flat Reservation, Idaho, projected improvements were postponed on account of unsettled conditions.

At the Malheur and Klamath Reservations, Oreg., deplorable conditions exist on account of uncertainty concerning the status of certain lands embraced within these reservations. These conditions are under investigation, and it is confidently expected that both these reservations, which are of world-wide fame as natural breeding places for birds, and which should be unique and valuable assets not only for the immediate locality but also for the Nation, will be permanently preserved for the public benefit, and not be sacrificed for the temporary advantage of a few interested persons.

On the Hawaiian Islands Reservation a warden resident at Honolulu has been appointed to keep the bureau informed regarding conditions there.

The reservations in Florida are very inadequate to preserve what formerly was the most wonderful bird population of North America. The time when effective action is practicable is rapidly passing. With proper measures taken at once for establishing extensive refuges in southern Florida, one of the most wonderful assets of the State and of the Nation can be preserved from annihilation.

Reservations about the Mississippi delta were utilized during the year in securing material for a study of the effect of fish-eating birds upon commercial fisheries. A representative of the bureau visited the breeding colonies of Caspian terns and brown pelicans on the Breton and Tern Islands reservations in June; the latter reservation, near the Pass à l'Ouvre, is commonly known as the "Mud Lumps."

Increased protected areas suitable for breeding places for the migratory wild geese, ducks, cranes, swans, curlew, and shore birds should be provided. Additional wild-fowl refuges along the paths of migration are needed in order to secure improved and equalized opportunities for shooting wild fowl for food and for recreation, particularly in Iowa, Missouri, Kansas, and Illinois. All species of grouse and quail are also peculiarly subject to unnecessary and unwise depletion, which can best be minimized through reservations and provision of natural food supplies. The sage grouse requires special and immediate consideration.

There have been 28 convictions for violations of section 84 of the United States Criminal Code, prohibiting trespass on Federal bird reservations, with a number of cases still pending. Seven of these were for illegal shooting on the Malheur Lake Reservation, 19 on the Big Lake Reservation, and 2 on the Mosquito Inlet Reservation. It is hoped that these convictions will greatly strengthen respect for the law protecting the reservations.

THE MIGRATORY-BIRD TREATY AND LACEY ACTS.

The approval of the migratory-bird treaty act on July 3, 1918, to give effect to the treaty between the United States and Great Britain for the protection of migratory birds in the United States and Canada, concluded August 16, 1916, made possible the adequate protection of migratory birds in the United States. This act, which supersedes the migratory-bird law of 1913, contains many important provisions not found in the old law, especially those conferring on employees of the department appointed to enforce its provisions the powers of arrest, search, and seizure so necessary to its effective enforcement. Furthermore, the present act and the regulations thereunder contain many other new clauses covering the possession of migratory birds and the means by which they may be taken. It also provides for the collection and capture of birds for scientific and propagating purposes, as well as for the issuance of appropriate permits to kill any species of migratory bird found to be seriously injurious to agricultural or other interests.

The new law also supersedes the provisions of the Lacey Act with respect to the interstate shipment by common carrier of the dead bodies of wild birds and parts thereof, and adds new clauses pro-

hibiting the shipment or carriage of living as well as dead birds—migratory and nonmigratory—out of a State by any means whatever contrary to the laws of the State in which the birds were killed or from which they were carried or shipped. The provisions of the Lacey Act relating to the delivery to a common carrier for transportation of foreign animals and birds, the interstate shipment of wild animals and parts thereof, and the penalty for knowingly receiving illegal shipments still remain.

The first regulations under the treaty act adopted by the Secretary of Agriculture became effective on approval by the President July 31, 1918. Amendments to these regulations were adopted and became effective October 25, 1918.

The designation "district inspector," applied to those appointed to enforce the migratory-bird law of 1913, was changed to "United States game warden," and the office of chief United States game warden for the administrative officer directly in charge of the administration of the treaty act was created when the act became effective.

For the first year this act was administered with a force of only 15 full-salaried game wardens, and 45 deputy wardens paid when actually employed. Much assistance and cooperation was rendered by most of the State game departments, and about 150 United States deputy game wardens were appointed from the deputy State game wardens, who received only a nominal salary from the Federal Government.

The wardens employed by the bureau reported for prosecution 531 violations of the law. Convictions have been secured in 116 cases, in which fines were assessed ranging from \$1 to \$100 and costs, and aggregating \$2,580. Of the remainder, 216 cases have been reported to the solicitor of the department for prosecution and are still pending; 5 cases have been dismissed by Federal judges; grand juries refused to return true bills in 15 cases, which probably will be resubmitted to grand juries or prosecuted by information; 79 cases are still under investigation; and prosecutions were abandoned in 100 cases, due mainly to the fact that the violations were of a trivial character or the violators had already been convicted and adequately fined in State courts.

Convictions were secured in Federal courts as follows: Alabama, 28; Arkansas, 12; California, 4; Delaware, 1; Florida, 15; Georgia, 2; Idaho, 6; Illinois, 9; Iowa, 4; Louisiana, 1; Maine, 1; Maryland, 1; Minnesota, 2; Missouri, 4; New York, 3; Ohio, 3; South Carolina, 11; South Dakota, 1; Tennessee, 6; Texas, 1; and Virginia, 1.

Reports received to date show that 58 violators of both Federal and State laws were apprehended by United States deputy game wardens and were successfully prosecuted in State courts and fined an aggregate of \$1,918.75. The States in which these violations were prosecuted have thus benefited materially as a result of the cooperation of United States game wardens with State game authorities.

Wild ducks and other migratory birds of an approximate value of \$2,942.25 illegally killed or possessed, and aigrettes and plumes of other migratory birds of an estimated value of \$6,857.55 illegally possessed and trafficked in, have been seized. In most instances the birds seized which were fit for food have been released by the accused persons and donated to charitable or other public institutions and

much of the plumage seized has been turned over by the courts or the accused persons to the bureau to be used for scientific and educational purposes. The remaining birds and plumes are being held as evidence to await disposition by the court.

During the year 621 scientific permits and 465 propagating permits were issued. The number of propagating permits issued does not approximate the number of persons who captured or possessed and trafficked in migratory waterfowl during the year for propagating purposes. The law is new and most persons possessing such waterfowl have not as yet become familiar with its provisions. The public is rapidly learning the requirements of the law, however, and is showing a gratifying desire to comply with them.

Marked progress has been made in breaking up the illegal traffic in aigrettes. Aigrettes in the United States are mainly the plumes of the American egret and snowy heron, which birds have been exterminated in many of the rookeries and greatly reduced in numbers everywhere by plume hunters, who wantonly kill the birds during the breeding season.

The treaty act and the regulations thereunder make it unlawful to possess, purchase, sell, or transport aigrettes or the skins or plumes of any migratory birds except under permit for purely scientific purposes, but the skins and feathers of migratory game birds lawfully killed may be possessed without a permit. The wearing of aigrettes and plumes of migratory birds other than the feathers of migratory game birds lawfully killed is thus made unlawful, and it is believed that women will refrain from wearing aigrettes or other prohibited plumage as soon as they have become familiar with the provisions of the law. The market for these plumes will then be closed and a check placed upon the indiscriminate slaughter of these beautiful birds for their plumage.

The extent to which this illegal traffic has been conducted was indicated when United States game wardens armed with a Federal warrant searched the apartment of a Seminole Indian at Miami, Fla., and seized aigrettes valued at about \$3,000. It is reliably stated that the yearly earnings of this Indian from the sale of plumes to Florida tourists and others have for several years exceeded \$5,000. The Indian is now under bonds to await the action of the Federal court.

The constitutionality of the migratory-bird treaty act has been upheld by Federal courts in Arkansas, Missouri, and Texas. These decisions have removed to a large extent the doubt existing in some quarters concerning the validity of the act, and have been a decided deterrent to those inclined to violate the law.

In Illinois, Ohio, South Carolina, and South Dakota legislation was enacted bringing the State game laws into practical uniformity with the provisions of the migratory-bird treaty act and the regulations thereunder, making a total of 28 States that have conformed their laws for the protection of migratory birds to the Federal law and regulations. The laws of three other States are nearly in harmony with the Federal regulations.

Many species of migratory birds have had a marked increase under the existing treaty act. Waterfowl formerly driven to the far north by spring shooting have remained in steadily increasing numbers to breed in localities where few or none had previously nested for many years.

State game commissioners, sportsmen, and others have extended cordial support and cooperation in the enforcement of the law, and the general opinion prevails that the treaty act properly enforced will restore our migratory game birds to such numbers as will continue to afford abundant legitimate sport. At the same time there will be an increase in the useful insectivorous and other migratory nongame birds.

INTERSTATE COMMERCE IN GAME.

The designation "district inspector, interstate commerce in game," was changed to "United States game warden" when the migratory-bird treaty act, approved July 3, 1918, became effective, and the enforcement of the provisions of the Lacey Act was delegated to all United States game wardens—15 in number—but 4 of these wardens, who had been previously assigned solely to Lacey Act work, were continued during the year in the enforcement of that law. The remainder of the wardens devoted their time mainly to the enforcement of the treaty act, but rendered incidental services in the enforcement of the Lacey Act.

The increased number of wardens performing Lacey Act work has resulted in greatly increased activity in the suppression of illegal interstate shipments of game. During the year special efforts were made to minimize shipments of beaver and deer skins and deer. In this the bureau secured the cooperation of many responsible concerns dealing in furs and game. The high prices paid for furs have encouraged some trappers to capture illegally and ship beaver skins to the market, but, as a result of the bureau's educational work in regard to the law, many firms dealing in furs have refused to purchase beaver skins or to receive shipments from States that have a continuous close season on beaver. Many of these firms have not only discontinued sending quotations to trappers in States which prohibit the exportation of beaver skins, but have warned trappers not to consign to them beaver skins that have been illegally taken or shipped.

More than 1,000 interstate shipments of furs and game were investigated and 25 apparent violations of the Lacey Act were reported to the solicitor during the year. Of these violations, 12 were based on shipments which contained in the aggregate 27 carcasses of deer and 1,500 pounds of venison; 7 contained a total of 103 beaver skins; 2 contained 56 deerskins; 1 consisted of several shipments containing deer and elk hides; and 1 a shipment of aigrettes. Investigation of a large number of alleged illegal shipments is now in progress.

Violations of the Lacey Act reported for prosecution during the year to the solicitor originated in the following States: California, 1; Colorado, 1; Idaho, 1; Louisiana, 1; Maine, 5; Minnesota, 2; Montana, 2; New Hampshire, 4; Utah, 2; Vermont, 3; and Washington, 1. Twenty-three cases involving violations of the Lacey Act were disposed of in Federal courts. Seventeen prosecutions resulted in conviction of the accused and the payment of fines ranging from \$2 to \$1,000, the total amount of fines imposed being \$1,917. The other cases were not brought to trial.

Seventy-six cases, many of them involving the shipment of beaver skins, which for various reasons it seemed undesirable to prosecute in Federal courts, were referred by the bureau to State officials for

prosecution in State tribunals. In 74 of these cases the accused were convicted and fines aggregating \$3,085 were imposed. One offender was sentenced to 90 days in jail and another was paroled.

IMPORTATION OF BIRDS AND MAMMALS.

War conditions during the first half of the year exerted a marked influence on the importation of birds from foreign countries. Although the armistice was signed on November 11, 1918, restrictions on shipments were not removed until some months later, and even at the close of the fiscal year normal conditions had not been restored, so far as the trade in birds was concerned. Ordinarily the number of permits issued for the port of New York exceeds that for any other port, but this year, even including the permits for birds from Central and South American countries, it amounted to less than 7 per cent of the total. Very few shipments were received from Europe although two or three lots of canaries arrived from Liverpool, London, and Rotterdam, the Rotterdam consignment being the first from Holland since the early days of the war. The parrot trade with tropical American countries, which forms an important item under normal conditions, has only recently begun to revive, as shown by the receipt of two considerable consignments from Nicaragua and Colombia.

The number of permits issued during the year decreased about 10 per cent, from 300 in 1918 to 273 in 1919, and the number of inspections from 76 to 42. Many of the permits issued were for the entry of foxes from Canada, the total number being 335, as compared with 391 in 1918. At Honolulu permits were issued for the entry of 195 birds, including pheasants, and several miscellaneous cage birds. So far as known, no prohibited species were entered during the year.

During the latter part of October and the early part of November, reports were received to the effect that a contagious disease was prevalent on some of the fox farms on Prince Edward Island, and the issue of permits for the entry of foxes was temporarily suspended pending an investigation. Through the cordial cooperation of the Canadian authorities, an examination of conditions promptly made disclosed the fact that the malady was local and noncontagious. The precaution had the effect of assuring importers that the Department realized the importance of protecting their interests and effectually guarding against the introduction of any contagious disease.

The increase in the number of shipments received at San Francisco was marked and included not only birds from the Orient and Australia, but also for the first time some direct from the island of Java. For the first time in 20 years, the number of canaries imported from the Orient nearly equaled the number received from European ports. As was the case last year, the receipts of miscellaneous non-game birds included a number of rare species, particularly from the Orient and from Venezuela. Among the most interesting entries were several shipments from Java, one of which included a number of jay thrushes, reported as *Garrulax pectoralis*. The consignment from Rotterdam, which arrived in April, contained in addition to canaries and other song birds, 12 species of waterfowl and shore birds, including a number of European green-winged teal, garganey or

blue-winged teal, red-headed widgeon, and barnacle geese intended for exhibition in public zoological gardens or for propagation in private collections.

Among the rarer birds from Venezuela and Colombia were two Venezuela parrots (*Amazona barbadensis*), several bare-eyed robins (*Planesticus gymnophthalmus*), a puffbird (*Bucco bicinctus*), a cardinal (*Paroaria nigrigenis*), three black-necked screamers (*Chauna chavaria*), and several species of tanagers.

Reports of losses due to deaths among the birds en route were much more frequent than in any previous year. These were due in part to the long voyages from Australia and Java, but also to lack of care in handling the birds or packing them for shipment.

IMPORTATION OF QUAIL FROM MEXICO.

The regulations governing the importation of quail from Mexico remained in force without change during the past season, except that the time of entry was extended three weeks at the end of the season. The season was open in 1919 from February 15 to April 30. The ports of entry were the same as last year, Laredo and Eagle Pass, Tex., and New York City. Through cooperation of the Bureau of Animal Industry, the usual 10 days' quarantine was maintained at the two ports in Texas, and a thorough inspection of the birds was made during the period of detention. The first permit was issued January 8, 1919, and the number of quail for which permits were issued was 10,730, but the number released from quarantine was only 4,358, as compared with permits issued for 10,500 and the release of 5,205 in 1918.

Notwithstanding the fact that preparations were made long in advance of the season, both by importers and by several of the State game commissioners, to secure a large number of birds, the total number of quail secured was so small that only a fraction of the orders could be filled. The long-continued drought in the Southwest, and particularly in the States of Coahuila and Tamaulipas, where most of these quail are captured, appears to have so reduced the number of quail that it was impossible to secure birds to meet the demand. Comparatively few birds held died during the quarantine period, and no case of quail disease was reported.

INFORMATION CONCERNING GAME LAWS.

The regular annual publications, including a directory of officials and organizations concerned with the protection of birds and game, the nineteenth annual summary of game laws, and a general poster showing open seasons for game in the United States and Canada, were issued and were widely distributed. The special poster showing open seasons in North Carolina, where a multitude of local laws apply to particular counties, has been discontinued. Copies of all changes in State laws relating to game were received, carded, and indexed for reference.

The Summary of the Game Laws of the United States and Canada for this year is the nineteenth annual publication of this bulletin. It is of widespread interest among sportsmen and conservationists and is of much practical service. An edition of 100,000 copies was required to meet the demand and supply the necessary distribution.

REPORT OF THE CHIEF OF THE DIVISION OF ACCOUNTS AND DISBURSEMENTS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF ACCOUNTS AND DISBURSEMENTS,
Washington, D. C., October 1, 1919.

SIR: I have the honor to submit herewith a report of the work of the Division of Accounts and Disbursements for the fiscal year ended June 30, 1919.

Respectfully,

A. ZAPPONE,
Chief of Division.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

CHARACTER OF WORK.

The chief of the division and disbursing clerk is charged by the Secretary of Agriculture with the duty of preparing all requisitions for the advance of public funds from the appropriations for the Department of Agriculture to the disbursing clerk and to special disbursing agents charged with the disbursement of public funds; the keeping of accounts and appropriations ledgers relating to the advance and disbursement of all items of appropriations; and the examination and payment of all vouchers and pay rolls submitted from the various offices, bureaus, and services of the department. He performs such other duties as may be prescribed by the Secretary.

WORK OF THE YEAR.

APPROPRIATIONS, EXPENDITURES, ETC.

To carry on the work of the Department of Agriculture during the fiscal year ended June 30, 1919, Congress appropriated \$27,875,353 in the agricultural act for that fiscal year; in addition to which permanent annual appropriations, special appropriations, deficiency appropriations, and the appropriation for printing and binding were available, amounting to \$90,110,422.60, making a total of \$117,985,775.60, of which sum \$47,990,477.51 was expended, leaving a balance at the end of the fiscal year of \$69,995,298.09. This balance includes \$65,000,000 appropriated for the construction of rural post roads and which amount will be available until expended, so the net balance for the fiscal year 1919 is only \$4,995,298.09 and which is nearly all covered by outstanding liabilities.

Supplemental accounts for the year 1918 were also paid, amounting to \$3,589,301.83.

On June 30, 1919, the unexpended balances for the year 1917, amounting to \$1,804,318.96, were finally covered into the Treasury to the "Surplus fund."

There were received, examined, and paid by this office 210,377 vouchers and pay rolls, which required the issuance of 342,882 checks on the Treasurer of the United States.

There were also sent to the Treasury Department for payment 9,488 accounts.

LOST CHECKS.

During the year 294 checks were lost in transit through the mails or by the payees, and were duplicated by this office.

PUBLIC MONEYS RECEIVED FROM VARIOUS SOURCES.

There were received from various sources and deposited in the Treasury to the credit of the proper funds the following sums:

Telegrams over Government lines.....	\$6, 146. 75
Sale of cotton standards.....	5, 665. 31
Cost of cotton-futures disputes.....	10, 454. 20
Sale of loose cotton.....	34, 693. 24
Cost of grain standards appeals.....	7, 545. 91
Cost of market inspection of perishable food products.....	19, 227. 56
Classification of cotton.....	1, 491. 75
Sales of nitrate of soda to farmers.....	8, 768, 268. 85
Sale of photo prints and lantern slides.....	688. 47
Sale of hearings.....	178. 70
Receipts on account of war-tax collections.....	784. 32
Miscellaneous collections.....	4, 476. 55
Sale of card indexes.....	202. 75
Sale of seeds by the Bureau of Plant Industry.....	859, 650. 48
Sale of other miscellaneous Government property.....	240, 129. 61
Sales of products, agricultural station, Hawaii.....	61. 78
Sales of products, agricultural station, Alaska.....	1, 617. 76
Sales of products, agricultural station, Porto Rico.....	1, 648. 67
Sales of products, agricultural station, Guam.....	256. 31
Sales of products, agricultural station, Virgin Islands.....	699. 88
Cooperative work, Forest Service.....	547, 928. 89
Forest Reserve fund.....	4, 405, 079. 56
Refunds on mileage books, etc.....	441, 678. 21
Transfers from other departments for work done and supplies furnished.....	296, 024. 49
Total.....	15, 654, 600. 00

STATEMENT OF APPROPRIATIONS, DISBURSEMENTS, AND UNEXPENDED BALANCES
FOR THE UNITED STATES DEPARTMENT OF AGRICULTURE.

[Fiscal years 1839 to 1904, inclusive.]

Fiscal year.	Amount appropriated.	Amount disbursed.	Amount unexpended.	Fiscal year.	Amount appropriated.	Amount disbursed.	Amount unexpended.
1839..	\$1,000.00	\$1,000.00	.....	1872..	\$197,070.00	\$195,977.25	\$1,092.75
1840..	.....	.....	.....	1873..	202,440.00	201,321.22	1,118.78
1841..	.....	.....	.....	1874..	257,690.00	233,765.78	23,924.22
1842..	1,000.00	1,000.00	.....	1875..	337,380.00	321,079.83	16,300.17
1843..	.....	.....	.....	1876..	249,120.00	198,843.64	50,276.36
1844..	2,000.00	2,000.00	.....	1877..	194,686.96	188,206.19	6,480.77
1845..	2,000.00	2,000.00	.....	1878..	198,640.00	197,634.94	1,005.06
1846..	3,000.00	3,000.00	.....	1879..	206,400.00	206,360.00	40.00
1847..	3,000.00	3,000.00	.....	1880..	199,500.00	198,361.72	1,138.28
1848..	4,500.00	4,500.00	.....	1881..	275,460.31	267,608.84	7,851.47
1849..	3,500.00	3,500.00	.....	1882..	363,011.05	354,482.39	8,528.66
1850..	5,500.00	5,500.00	.....	1883..	456,336.11	438,941.72	17,454.39
1851..	5,500.00	5,500.00	.....	1884..	416,641.10	413,618.09	3,023.04
1852..	5,000.00	5,000.00	.....	1885..	655,930.25	558,934.89	96,995.36
1853..	5,000.00	5,000.00	.....	1886..	677,973.22	519,196.11	158,777.11
1854..	10,000.00	10,000.00	.....	1887..	657,641.81	628,287.14	29,354.67
1855..	50,000.00	50,000.00	.....	1888..	1,027,219.06	1,011,282.62	15,936.44
1856..	30,000.00	30,000.00	.....	1889..	1,134,480.60	1,033,590.22	100,890.38
1857..	75,000.00	75,000.00	.....	1890..	1,170,133.11	971,823.62	198,315.49
1858..	63,500.00	63,157.25	\$342.75	1891..	1,372,049.21	1,266,277.36	105,771.85
1859..	60,000.00	60,000.00	.....	1892..	2,203,655.75	2,253,262.29	50,393.46
1860..	40,000.00	40,000.00	.....	1893..	2,540,060.72	2,355,431.25	184,630.47
1861..	60,000.00	60,000.00	.....	1894..	2,603,855.58	1,977,469.28	626,386.30
1862..	64,000.00	63,704.21	295.79	1895..	2,506,915.30	2,021,030.38	485,884.92
1863..	80,000.00	80,000.00	.....	1896..	2,584,013.22	2,034,916.42	489,096.80
1864..	199,770.00	189,270.00	10,500.00	1897..	2,448,763.53	2,348,512.98	100,250.55
1865..	112,304.05	112,196.55	107.50	1898..	2,467,902.00	2,425,510.44	42,391.56
1866..	167,787.82	167,787.82	.....	1899..	2,829,702.00	2,827,795.65	28,986.27
1867..	199,100.00	199,100.00	.....	1900..	3,006,022.00	2,947,603.42	58,418.58
1868..	279,920.00	277,094.34	1,925.66	1901..	3,304,265.97	3,239,137.39	65,128.58
1869..	172,593.00	172,593.00	.....	1902..	3,922,780.51	3,902,675.79	20,104.72
1870..	156,440.00	151,596.93	4,843.07	1903..	5,015,846.00	4,724,230.84	281,615.16
1871..	188,180.00	186,876.81	1,303.19	1904..	5,025,024.01	4,969,311.64	55,712.37

REPORT OF THE CHIEF OF THE DIVISION OF PUBLICATIONS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF PUBLICATIONS,
Washington, D. C., August 25, 1919.

SIR: I have the honor to submit herewith a report of the work of the Division of Publications for the fiscal year ended June 30, 1919.

Respectfully,

EDWY B. REID,
Chief of Division.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

SUMMARY.

The bulletins and other publications of the Department of Agriculture distributed through the Division of Publications during the fiscal year 1919 totaled 62,218,829 copies. Ninety new Farmers' Bulletins were issued, besides many other bulletins and circulars of a popular nature, and great numbers of posters especially prepared to assist in the conservation campaigns of the war period. New publications of all classes numbered 840, and reprints were 401, making 1,241 publications issued during the year. Job printing and binding received from the Government Printing Office amounted to more than 44½ million pieces, while the aggregate of printing and binding was more than 100 million pieces.

A greater proportion of the publications than ever before were written in so direct a style that the farmer could put into use the information obtained in the department's investigations.

Much progress was made during the year in improving the Farmers' Bulletins in particular. These bulletins have been made shorter; historical matter and scientific details have been largely excluded; technical terms have been avoided. The text has been made simple and direct, although much remains to be accomplished.

The outside appearance of the Farmers' Bulletins has been radically changed by the use of specially designed covers. In many cases a single photograph illustrating the subject covers both the front and the back page, the title of the bulletin being lettered on the photograph in strong but attractive letters. The name of the department and the number of the bulletin are placed at the top for convenience. The department seal is used in all cases as the distinctive "trademark" of the department's publications. Containing only these few elements, the front page makes a simple and forceful appeal to the interest of the reader and leads him to turn the cover.

The inside make-up of the Farmers' Bulletins also in many cases is varied by typographical devices intended to set out and emphasize the salient features of the text, so as to enhance the interest and elucidate the subject.

During the year a new series of publications was inaugurated, known as Department Circulars. These take the place of numerous

circulars and leaflets heretofore issued by the various bureaus, and being numbered in a single series avoid the complexity of numbering which formerly existed. The bulk of the department's informational publications hereafter will be found in a few series—Department Bulletins, Farmers' Bulletins, Department Circulars, and the Year-book. Pronouncements of an administrative nature will be included in the circulars of the Office of the Secretary. The Service and Regulatory Announcements and the established periodicals, of course, continue, such as the Weekly News Letter, the Monthly Crop Reporter, Public Roads, the Journal of Agricultural Research, the Monthly Weather Review, and the Experiment Station Record.

A saving of about \$7,000 and 14 tons of paper was made in the job printing by standardizing sizes of blank forms, using economical kinds of paper, and reducing the number of operations. Since many of the forms are permanent, much of this saving will be perpetuated.

During the year 26 reels of motion-picture films were completed on 18 subjects, designed to aid in the campaign for increased production of crops and conservation of food and fuel. Camera work was completed for 17 other films. At the close of the year 244 reels of film for 57 subjects were available for distribution. Between four and five million people saw the department's educational films during the year.

FACILITATING PRINTING.

The department's printing was more or less unavoidably delayed during the year by the congestion of emergency war printing imposed upon the Government Printing Office. Considering the conditions, the most necessary printing was delivered with remarkable dispatch. Since the cessation of hostilities the volume of the Government's emergency work has decreased, yet the Printing Office is able to deliver the bulk of this department's printing with only fair promptness. At all times the facilities of the Government Printing Office appear to be fully taxed. In numerous instances a bulletin, report, pamphlet, or administrative blank is needed at once, and the several serial publications should come out on time. It is not always possible, however, to get as prompt service as should be rendered this department by the Government Printing Office. Every effort is made in the department to reduce to the minimum the number of rush requisitions, but they are often unavoidable. In such cases the department endeavors to cooperate with the Printing Office by furnishing perfect copy, eliminating unimportant changes, and promptly returning the proof. This department, of course, is the most competent judge as to the necessity for haste in the printing of a particular job, and it is hoped in the future the Government Printing Office will find it possible to use its great resources for speedy execution more to the benefit of the department.

PROMPT HANDLING OF PROOF.

Some reduction in the time consumed in handling proofs in the department was apparent during the year, but further cooperation on the part of issuing offices is necessary to speed up the printing. Scarcely ever is the retention of proof for more than three days for critical examination justified. The examination of proof should be undertaken immediately upon its receipt and completed at the earliest possible moment. Prompt return of proof will invite prompt

handling of the work at the Government Printing Office. The time consumed by the bureaus in the examination of proof could be reduced very materially if the proof received immediate attention and if the efforts of the issuing office were confined to proof reading and not extended to making changes which should have been made in the editing of the original manuscript before it was submitted for publication. Frequently the return of proof is delayed by sending it to the author when in the field. This practice should be discouraged in so far as it is practicable.

APPROPRIATION FOR PRINTING.

The regular appropriation for printing and binding for the department for the year was \$600,000, which was \$50,000 less than for the preceding year. On account of this reduction the publication work was of necessity curtailed, and many important new bulletins and reports were not printed, although the acquisition of the information they contained was imposed by law upon the department. In every act appropriating funds for the department new work and additional investigations are authorized by Congress, the results of which can become available for the use and information of the people only by means of published reports. Some method of checking up the department's requirements for printing with the appropriation for its maintenance should be adopted. In this way only can the amount needed for printing be accurately ascertained.

Of the appropriation of \$600,000 for printing, \$200,000 is provided for Farmers' Bulletins, \$47,000 for the Weather Bureau, the two items totaling \$247,000, leaving \$353,000 for all other printing for the department. Under provisions of law the department is required to publish the Yearbook, its proportionate cost for the latest issue being \$19,958.46; the Annual Reports of the Department of Agriculture, which involved an expenditure of \$1,234.25; the Soil Surveys, \$32,074.25 (although considerably more has been spent in other years and \$50,000 would scarcely be adequate); the Crop Reporter and monthly schedules, \$32,693.96; other reports, including expenditures in the department, the special report on expenditures involved in meat inspection, and certain minor reports required to be made, aggregating \$3,500; the report on work and expenditures of the agricultural experiment stations and on agricultural extension work, \$3,437.53. The total of these reports which are authorized by law and required to be printed and paid for from the regular appropriation was approximately \$92,898.55, leaving for general printing only \$260,101.55. More than one-half of this amount was required for administrative printing (orders, decisions, blank forms, stationery, etc.), leaving an amount entirely inadequate for the department's informational publications. The scientific bulletins particularly should be better provided for, as these are fundamentally the most important class of the department's publications, setting forth the results of the studies for which the department was established.

The increase in the printing fund has not kept pace with the rapid growth of the department during the last few years. If the department is successfully and efficiently to perform its function of acquiring and diffusing useful information among the people, adequate funds for printing will be needed and a considerable increase should be made in the appropriation for the fiscal year 1921.

EXPENDITURES FOR PRINTING AND BINDING.

From the regular appropriation for printing and binding (\$600,000) the expenditures were \$599,982.75, leaving a balance of \$17.25.

The number of requisitions on the Public Printer was 2,886, as compared with 3,843 for the preceding year. The decrease in the number of requisitions is due to the policy of combining in one requisition a number of pieces of work of similar character. There was no decrease in the volume of printing ordered.

SUMMARY OF EXPENDITURES FROM THE REGULAR FUND FOR PRINTING AND BINDING.

The following statement shows the amounts expended from the regular appropriation, arranged by classes of printing and by bureaus.

Expenditures from the regular fund for printing and binding for the fiscal year ended June 30, 1919.¹

ARRANGED BY CLASSES OF PRINTING, AND SHOWING FOR EACH CLASS THE PER CENT OF TOTAL.

Class.	Amount.	Per cent.
Farmers' Bulletins.....	\$167,199.56	27.87
Department Bulletins and unnumbered publications.....	60,455.90	10.08
Periodical publications.....	139,995.90	23.33
Congressional publications.....	64,160.77	10.69
Compilations of laws, manuals, fiscal regulations, etc.....	5,169.54	.86
Miscellaneous administrative circulars, orders, decisions, etc.....	31,316.17	5.22
Separates and unnumbered pamphlets.....	18,140.11	3.03
Posters, placards, labels, maps, etc.....	5,544.28	.90
Binding.....	11,289.63	1.88
Index cards.....	12,139.73	2.02
Blank forms.....	51,274.52	8.55
Blank books.....	21,268.54	3.54
Letterheads.....	11,932.99	1.99
Envelopes.....	90.83	.02
Memorandum sheets.....	4.28	.01
Total.....	599,982.75	100

ARRANGED BY BUREAUS, AND SHOWING ESTIMATED COST OF WORK ORDERED BUT NOT COMPLETED.

Bureau.	Expenditures.			Estimates on work carried to 1920.	Total of expenditures and estimates.
	Job work and binding.	Publications.	Total expenditures.		
Bureaus:					
Division of Accounts and Disbursements.....	\$1,300.35	\$25.36	\$1,325.71	\$221.10	\$1,546.81
Bureau of Animal Industry.....	3,438.04	12,517.64	15,955.68	1,229.78	17,185.46
Bureau of Biological Survey.....	1,666.87	5,253.67	6,920.54	946.02	7,866.56
Bureau of Chemistry.....	3,828.70	7,603.46	11,432.16	909.74	12,341.90
Bureau of Crop Estimates.....	12,115.64	24,777.84	36,893.48	3,421.79	40,315.27
Bureau of Entomology.....	2,245.98	9,165.96	11,411.94	724.92	12,136.85
Office of Farm Management.....	440.77	11,973.58	12,414.35		12,414.35
Federal Horticultural Board.....	804.23	1,248.46	2,052.69	248.50	2,301.19
Forest Service.....	10,821.95	12,121.15	22,943.10	6,122.40	29,065.50
Insecticide and Fungicide Board.....	124.83	1,106.16	1,230.99	77.78	1,308.77
Library.....	4,947.34	410.87	5,358.21	3,053.61	8,411.82
Bureau of Markets.....	10,752.85	8,397.24	19,150.09	3,190.53	22,340.62
Bureau of Plant Industry.....	6,615.00	32,900.37	39,515.37	4,421.00	43,936.37
Bureau of Public Roads.....	1,446.57	7,699.98	9,146.55	1,209.62	10,356.17
Division of Publications.....	1,108.39	8,876.66	9,985.05	2,179.26	12,164.31
Office of the Secretary.....	12,039.21	122,359.08	134,398.29	32,208.29	166,606.58
Bureau of Soils.....	386.61	34,263.34	34,649.95	32,935.92	67,585.87
Solicitor.....	123.97	126.67	250.64	7.82	258.46
States Relations Service.....	24,651.31	29,726.17	54,377.48	6,960.95	61,338.43
Weather Bureau.....	14,686.19	25,297.52	39,983.71	3,360.00	43,343.71
Projects:					
Agricultural Atlas.....		2,977.00	2,997.00	5,282.88	8,279.88
Farmers' Bulletins—Congressional reprints.....		127,589.77	127,589.77	10,405.30	137,995.07
Total.....	113,544.80	486,437.95	599,982.75	119,117.21	719,099.96

¹ Including publications of the Weather Bureau.

As usual, a considerable number of requisitions for printing and binding were forwarded to the Government Printing Office upon which work was either not undertaken, or, if undertaken, completed only in part. The estimated cost of such uncompleted work for the year ended June 30, 1919, was \$119,117.21. This large "carry-over" was due to the insufficiency of the appropriation to meet the printing requirements of the department.

DETAILED STATEMENT OF EXPENDITURES FROM THE REGULAR FUND FOR PRINTING AND BINDING, BY CLASSES OF WORK, FOR EACH BUREAU.

The following statement shows in detail the expenditures for printing and binding for the various bureaus, divisions, and offices, chargeable against the regular appropriation of \$600,000. The classes of work and the number of copies are given.

The expenditures include, besides the charges for work ordered and completed during the year, the final charges for work ordered in the fiscal year 1918 but not completed in that year, and the first charges on work ordered in the fiscal year 1919 and completed only in part, the final charges for which will be paid from the appropriation for 1920.

The number of copies given is the number billed from the Government Printing Office during the year. In some cases deliveries were made in two or more lots, the early deliveries falling in one fiscal year and the later deliveries in the succeeding year. For this reason and because emergency publications charged to the food production act and certain other acts are not included in this table, the numbers given here do not agree entirely with the editions ordered, as given in the table of publications issued during the year (pp. 9-10), which includes emergency publications.

Neither does the number of copies agree exactly with the number received in the Distribution Section, which also includes emergency publications.

Expenditures from the regular fund for printing and binding, with the number of copies (arranged by classes of printing and by bureaus and offices), for the fiscal year ended June 30, 1919.

[Quantities and costs are those billed by the Government Printing Office for deliveries made during the year.]

Bureau or project.	Grand total.		Publications.									
	Copies.	Cost.	Total publications.		Farmers' Bulletins.		Department Bulletins, reports, etc.		Periodicals.		Congressional (Yearbook, administrative circulars, soil surveys, etc.).	
			Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.
Bureaus:												
Division of Accounts and Disbursements	447,530	\$1,325.71	602	\$25.36							602	\$25.36
Bureau of Animal Industry	3,197,151	15,955.68	792,941	12,517.64			154,500	\$7,964.30			2,501	224.88
Bureau of Biological Survey	786,545	6,920.54	241,000	5,293.67			99,500	3,301.66			5,000	118.65
Bureau of Chemistry	1,663,906	11,432.16	333,901	7,693.46			91,500	3,941.70			2,501	81.88
Bureau of Crop Estimates	6,943,801	30,893.48	2,368,801	24,777.84			20,000	1,179.05	2,206,800	22,292.21	2,501	49.78
Bureau of Entomology	11,411,394	11,411.94	571,469	9,163.96			86,418	3,174.19			1,151	72.30
Office of Farm Management	818,156	12,414.35	806,501	11,973.58			32,500	1,716.14			2,001	38.53
Federal Horticultural Board	340,756	2,052.69	33,801	1,248.46							2,501	81.70
Forest Service	3,774,320	22,943.10	408,091	12,121.15			212,500	7,160.71			2,501	146.86
Insecticide and Fungicide Board	107,679	1,230.99	65,501	1,106.16							2,501	28.04
Library	416,605	5,358.21	202,801	410.87							801	76.80
Bureau of Markets	7,318,896	39,515.37	822,001	8,397.24			363,000	3,283.62			3,001	142.83
Bureau of Plant Industry	3,876,659	19,515.37	1,673,926	32,900.37			211,500	12,570.50			2,501	115.61
Bureau of Public Roads	426,636	9,146.55	123,201	7,699.98			18,500	1,497.93			2,501	72.86
Division of Publications	5,289,940	9,983.05	4,416,001	8,876.66					32,000	4,706.87		
Office of the Secretary	11,903,679	134,398.29	8,004,673	122,359.08					2,045,000	3,395.28	1,001	140.72
Bureau of Soils	95,970	34,649.95	54,501	34,283.34			157,500	1,523.54	7,667,390	85,418.16	40,531	27,151.12
Office of the Solicitor	41,562	250.64	1,001	126.67			5,500	2,104.54			43,501	32,113.86
States Relations Service	8,634,090	54,377.48	788,551	29,726.17			99,200	3,679.94			1,001	126.67
Weather Bureau?	9,852,337	80,983.71	58,536	25,297.52			37,535	13,358.08	135,000	15,484.82	2,001	111.84
Project:									20,000	8,698.56	1,001	3,240.88
Agricultural Atlas	13,690	2,997.00	13,690	2,997.00								
Farmers' Bulletins—Congressional reprints	11,452,875	127,589.77	11,452,875	127,589.77								
Total	78,985,679	599,982.75	33,294,365	486,437.95	14,265,125	167,199.56	1,509,653	60,455.90	12,106,190	139,995.90	121,600	64,160.77

Bureau or project.	Publications—Continued.						Posters, placards, labels, etc.		Binding.		Index cards.	
	Administrative circulars, orders, decisions, notices, etc.		Separates and unnumbered pamphlets.		Compilations of laws, manuals, fiscal regulations, etc.							
	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.
Bureaus:												
Division of Accounts and Disbursements.....	161,990	\$2,312.84	48,950	\$844.22	.....	.....	12	\$1.88	1	\$2.05	150,500	\$259.92
Bureau of Animal Industry.....	48,000	345.80	18,500	240.99	.....	.....	650,300	529.09	10	18.07	233,200	657.55
Bureau of Biological Survey.....	228,000	3,369.85	11,900	210.03	.....	.....	36,850	449.18	95	194.32	25,500	65.02
Bureau of Chemistry.....	107,500	165.31	32,000	1,091.49	.....	.....	10,230	35.96	1,125	1,104.16	74,200	196.86
Bureau of Crop Estimates.....	20,100	73.76	18,800	511.65	.....	.....	4,700	719.51	.....	.....	92,000	166.43
Bureau of Entomology.....	2,000	153.36	10,000	173.66	.....	.....	188,450	576.76	56	121.16	206,300	601.67
Office of Farm Management.....	86,600	1,138.46	4,700	28.30	.....	.....	155	16.08	.....	.....	.....	.....
Federal Horticultural Board.....	149,000	3,296.19	33,000	94.28	.....	.....	325	56.31	30	39.22	8,300	50.41
Forest Service.....	63,000	1,078.12	.....	.....	11,000	1,423.11	60,750	940.04	10,754	136.11	951,700	2,167.10
Insecticide and Fungicide Board.....	202,000	334.07	.....	.....	.....	.....	78	8.12	.....	.....	11,000	34.64
Library.....	268,000	2,940.39	98,000	1,045.47	.....	.....	15	2.36	15,289	4,738.61	55,000	60.77
Bureau of Markets.....	495,000	2,790.06	72,675	3,552.24	.....	.....	7,475	148.73	.....	.....	384,450	730.56
Bureau of Plant Industry.....	3,200	72.25	17,000	241.49	.....	.....	39,704	397.83	9,772	273.41	738,100	1,023.62
Bureau of Public Roads.....	25,000	62.53	2,345,000	5,278.13	.....	.....	615	58.74	.....	.....	47,600	211.12
Division of Publications.....	109,087	6,709.78	30,165	1,556.48	.....	.....	250	22.73	22	42.47	454,072	350.91
Office of the Secretary.....	.....	.....	5,500	44.94	.....	.....	805	63.15	100,300	643.03	161,500	785.03
Bureau of Soils.....	.....	.....	.....	.....	.....	.....	348	34.91	21	47.45	5,400	28.43
Office of the Solicitor.....	535,600	6,473.40	7,000	229.74	.....	.....	60	9.42	.....	.....	13,000	26.75
States Relations Service.....	.....	.....	.....	.....	9,750	3,746.43	11,350	814.16	2,298	1,101.85	4,696,517	4,652.67
Weather Bureau.....	.....	.....	.....	.....	.....	.....	15,300	659.32	5,335	2,397.21	16,400	70.27
Project:												
Agricultural Atlas.....	.....	.....	13,600	2,997.00	.....	.....	.....	.....	.....	.....	.....	.....
Total.....	2,504,077	31,316.17	2,766,880	18,140.11	20,840	5,169.54	1,027,972	5,544.28	145,900	11,289.63	8,314,739	12,139.73

¹ Figures in this table do not include publications charged against the funds provided in the food production act, or in certain other acts administered by the various bureaus.

² The Division of Publications does not have supervision of the appropriation for the Weather Bureau. A statement of the expenditures for that bureau, however, is included in order to show the total expenditures from the regular printing fund for printing and binding for the department.

Expenditures from the regular fund for printing and binding, with the number of copies (arranged by classes of printing and by bureaus and offices), for the fiscal year ended June 30, 1919—Continued.

Bureau.	Blank books.		Blank forms.		Letterheads.		Envelopes.		Memorandum sheets.	
	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.
Bureaus:										
Division of Accounts and Disbursements.....			208,424	\$1,036.50						
Bureau of Animal Industry.....			1,320,500	2,233.33						
Bureau of Biological Survey.....			270,000	688.30						
Bureau of Chemistry.....	1,600	\$343.93	507,356	1,092.65	212,500	\$270.05				
Bureau of Crop Estimates.....			3,570,900	10,401.75	737,303	1,055.14				
Bureau of Entomology.....			203,500	389.84	507,500	827.95				
Office of Farm Management.....	12	2.07	11,000	114.67	345,000	554.48				
Federal Horticultural Board.....	509	310.02	177,800	501.64	60,000	98.71				
Forest Service.....	500	57.94	177,800	501.64	247,000	391.27				
Insecticide and Fungicide Board.....	29,475	2,301.33	2,076,550	4,866.10						
Library.....	100	27.01	31,000	55.06						
Bureau of Markets.....			128,500	120.33	15,000	25.27				
Bureau of Plant Industry.....			2,304,260	3,928.52	3,830,003	5,627.54				
Bureau of Public Roads.....	18,651	2,334.15	677,500	1,259.59	716,503	1,311.30	2,500	\$5.10		
Division of Publications.....			115,198	797.44	140,000	338.28				
Office of the Secretary.....	255	51.95	416,840	576.77	2,000	4.71	500	8.85		
Bureau of Soils.....	100,501	4,224.62	3,398,900	5,948.04	128,000	355.00	6,500	11.03	2,500	\$4.23
Office of the Solicitor.....	700	186.67	10,000	46.61	25,000	42.54				
States Relations Service.....	1	17.94	12,000	39.84	15,500	30.02				
Weather Bureau.....	763,174	9,778.67	1,685,700	7,235.39	1,002.75		100,000	65.82		
	1,065	1,627.25	9,755,700	9,932.15	586,500					
Total.....	916,535	21,288.54	27,636,168	51,274.52	7,538,000	11,932.99	109,500	90.83	2,500	4.23

Total of the regular appropriation for printing and binding for the department, \$400,000; total expenditures, \$599,982.75; balance, \$17.25.

STATISTICS OF THE PUBLICATION WORK.

The statements that follow show in detail the publication work of the department for the year:

Contributions by the various bureaus to the series of Department Bulletins and to the Farmers' Bulletin series issued during the year.¹

Bureau.	Department Bulletins.						Farmers' Bulletins.					
	New.			Reprints.			New.			Reprints.		
	Number.	Pages.	Copies.	Number.	Pages.	Copies.	Number.	Pages.	Copies.	Number.	Pages.	Copies.
Animal Industry.....	11	319	74,000	2	23	7,000	14	326	82,000	51	1,165	2,595,000
Biological Survey.....	2	49	12,000	1	49	2,500	3	125	170,000	12	281	418,000
Chemistry.....	9	203	45,550	5	144	31,000				3	99	45,000
Crop Estimates.....	4	113	20,000									
Entomology.....	14	452	83,000	1	16	5,000	18	330	750,000	29	633	790,500
Farm Management.....	9	364	44,500				21	588	1,040,000	10	219	415,000
Forest Service.....	12	702	105,000	3	103	1,500				2	47	25,000
Markets.....	9	185	260,000	3	255	21,000	2	44	93,000	6	103	170,000
Plant Industry.....	23	1,110	142,000	8	201	33,000	29	766	1,500,000	79	2,068	2,294,500
Public Roads.....	4	238	16,500				3	128	370,000	8	195	106,000
Secretary.....										1	12	30,000
Soils.....	2	197	4,000	1	23	1,500				2	78	80,000
States Relations Service.....	6	146	52,000	6	157	6,000				27	742	3,547,000
Weather Bureau.....										1	31	45,000
Total.....	105	4,078	858,550	30	959	111,500	90	2,307	4,005,000	231	5,673	10,561,000

¹A new series, known as Department Circulars, was begun during the year, but separate statistics for these can not be given at this time.

New publications and reprints issued during the year ended June 30, 1919.

PUBLICATIONS OF ALL CLASSES EXCEPT PERIODICALS.¹

Class.	New publications.			Reprints.		
	Number.	Pages.	Copies.	Number.	Pages.	Copies.
Department Bulletins.....	105	4,078	932,550	30	959	111,500
Farmers' Bulletins.....	90	2,307	4,075,000	231	5,673	10,561,000
Department Circulars.....	22	298	2,041,000			
Soil Surveys.....	40	2,043	42,000			
Secretary's Report to the President.....	1	54	13,500			
Annual Reports, Department of Agriculture.....	1	520	400			
Annual reports, bureaus, divisions, and offices.....	22	674	55,357			
Yearbook separates.....	34	697	243,500	5	190	10,500
Journal of Agricultural Research separates.....	120	1,928	111,690			
Miscellaneous separates and pamphlets.....	32	1,813	5,293,100	8	253	1,366,789
Circulars, Office of Secretary.....	33	345	2,801,500	10	126	451,000
Circulars, bureaus, divisions, and offices.....	67	879	5,586,500	31	400	947,000
Miscellaneous bulletins and reports.....	10	496	28,700	3	578	5,000
Orders, notices, decisions, etc.....	22	69	171,000	61	334	107,000
Service and Regulatory Announcements.....	54	1,139	890,450	22	725	29,500
Total.....	653	17,340	22,286,240	401	9,118	13,589,289
New publications and reprints combined.....				1,054	26,358	35,875,529

¹ Including emergency publications but not including publications of the Weather Bureau.

New publications and reprints issued during the year ended June 30, 1919—Contd.

PERIODICAL PUBLICATIONS.¹

Name of periodical.	Bureau or office.	Number of issues.	Pages.	Copies.
Weekly News Letter.....	Secretary.....	52	832	6,958,000
Journal of Agricultural Research.....	do.....	42	1,801	80,200
Experiment Station Record.....	States Relations.....	19	2,293	142,500
Monthly Crop Reporter.....	Crop Estimates.....	12	160	2,197,550
Monthly List of Publications.....	Publications.....	12	52	2,465,000
Public Roads.....	Roads.....	10	481	36,000
Seed Reporter.....	Markets.....	11	88	270,500
Food Survey.....	do.....	29	380	788,000
Total periodicals.....		187	6,087	12,937,750

¹ Not including publications of the Weather Bureau.

In addition to the periodical publications named in this list, the Office of Information issued to the press the "Food and Farming Weekly," a 3-column sheet 7½ by 19 inches in size. Of this 270,400 copies were issued during the year. The Office of Information also issued to the press the "Special Information Service," an 8-column sheet 24 by 24 inches in size. During the year 196,100 copies of this sheet were issued.

The Superintendent of Documents, Government Printing Office, distributed to paid subscribers 14,021 copies of the Journal of Agricultural Research; 12,859 of the Weekly News Letter; 6,972 of the Experiment Station Record; 1,608 of the Monthly Weather Review; 1,169 of Public Roads; and smaller numbers of other periodicals.

Copies of publications of all kinds, new and reprints, issued by the department, 1890-1919, inclusive.

Year.	Number of copies.	Year.	Number of copies.	Year.	Number of copies.	Year.	Number of copies.
1890.....	1,904,300	1898.....	6,280,365	1906.....	13,488,527	1914.....	38,186,392
1891.....	2,833,933	1899.....	7,075,975	1907.....	16,746,910	1915.....	36,075,561
1892.....	2,348,797	1900.....	7,152,428	1908.....	16,875,516	1916.....	39,098,239
1893.....	3,446,181	1901.....	7,889,281	1909.....	17,190,345	1917.....	47,023,635
1894.....	3,169,310	1902.....	10,586,580	1910.....	25,190,465	1918.....	197,259,399
1895.....	4,100,660	1903.....	11,698,564	1911.....	27,594,877	1919.....	149,737,125
1896.....	6,561,700	1904.....	12,421,386	1912.....	34,678,557		
1897.....	6,541,210	1905.....	12,475,157	1913.....	33,356,366		

¹ includes publications of the Weather Bureau and publications charged to the emergency fund for "stimulating agriculture."

FARMERS' BULLETINS.

New bulletins of the Farmers' Bulletin series to the number of 90 were issued during the year. The output of Farmers' Bulletins, including reprints of earlier numbers still in demand, aggregated 14,636,000 copies.

The following list gives the serial numbers and titles of the new Farmers' Bulletins issued during the year:

New Farmers' Bulletins issued during the year ended June 30, 1919.

- No.
905. Ways of Making Southern Mountain Farms More Productive.
 932. Rodent Pests of the Farm.
 941. Water Systems for Farm Homes.
 944. Controlling the Garden Webworm in Alfalfa Fields.
 945. Eradication of Bermuda Grass.
 951. Hog Pastures for the Southern States.
 952. Breeds of Light Horses.
 954. Disinfection of Stables.
 957. Important Poultry Diseases.
 959. The Spotted Garden Slug.
 960. Neufchatel and Cream Cheese: Manufacture and Use.
 961. Transferring Bees to Modern Hives.
 962. Velvet Beans.
 963. Tractor Experience in Illinois: A Study of the Farm Tractor under Corn-Belt Conditions.
 964. Farm Household Accounts.
 965. Growing Grain Sorghums in the San Antonio District of Texas.
 967. Purple Vetch.
 968. Cultivation and Utilization of Barley.
 969. Horse Beans.
 972. How to Use Sorghum Grain.
 973. The Soy Bean: Its Culture and Uses.
 974. Clearing Land.
 975. The Control of European Foulbrood.
 976. Cooling Milk and Cream on the Farm.
 977. Hay Caps.
 978. Handling Barnyard Manure in Eastern Pennsylvania.
 980. The Spinose Ear Tick and Methods of Treating Infested Animals.
 981. Farm Practices that Increase Crop Yields in Kentucky and Tennessee.
 982. Control of the Green Clover Worm in Alfalfa Fields.
 983. Bean and Pea Weevils.
 984. Home and Farm Drying of Fruits and Vegetables.
 985. Systems of Hog Farming in the Southeastern States.
 986. Farm Practices That Increase Crop Yields. The Gulf Coast Region
 988. Larkspur or "Poison Weed."
 990. Timothy.
 992. The Use of Machinery in Cutting Corn.
 993. Cooperative Bull Associations.
 995. Preventing Wood Rot in Pecan Trees.
 996. Steam Sterilization of Seed Beds for Tobacco and Other Crops.
 997. Terracing Farm Lands.
 998. Culture of the Logan Blackberry and Related Varieties.
 999. Sweet Potato Growing.
 1000. Crop Systems for Arkansas.
 1001. Growing Fruit for Home Use.
 1002. Canada Thistle and Methods of Eradication.
 1003. How to Control Billbugs Destructive to Cereal and Forage Crops.
 1004. The Gas Tractor in Eastern Farming.
 1005. Sweet Clover on Corn-Belt Farms.
 1006. The Wheat Jointworm and Its Control.
 1007. Control of the Onion Thrips.
 1008. Saving Farm Labor by Harvesting Crops with Live Stock.
 1009. Hay Stackers: How They May Be Used in the East and South to Save Labor.
 1010. Game Laws for 1918.
 1011. Woolly White Fly in Florida Citrus Groves.
 1012. Preparation of Bees for Outdoor Wintering.
 1013. Practical Hints for Running a Gas Engine.
 1014. Wintering Bees in Cellars.
 1015. Producing Family and Farm Supplies on the Cotton Farm.
 1016. Propagation and Culture of the Date Palm.
 1017. Cattle Scab and Methods of Control and Eradication.
 1018. Hemorrhagic Septicemia (Stockyards Fever, Swine Plague, Fowl Cholera, etc.).

- No.
 1019. Straining Milk.
 1020. Sweet Potato Weevil and Its Control.
 1022. Laws Relating to Fur-Bearing Animals, 1918.
 1023. Machinery for Cutting Firewood.
 1024. Currants and Gooseberries.
 1025. Larger Corn Stalk-Borer.
 1026. Strawberry Culture, South Atlantic and Gulf Coast Regions.
 1027. Strawberry Culture, Western United States.
 1028. Strawberry Culture, Eastern United States.
 1029. Conserving Corn from Weevils in the Gulf Coast States.
 1030. Feeding Horses.
 1031. Fig Growing in the South Atlantic and Gulf States.
 1032. Operating a Cooperative Motor Truck Route.
 1033. Muscadine Grape Paste.
 1034. Growing Sugar Cane for Sirup.
 1035. Farm Tractor in the Dakotas.
 1036. Care and Repair of Farm Implements: No. 5, Grain Separators.
 1037. "White Ants" as Pests in the United States and Methods of Preventing Their Damage.
 1038. Striped Cucumber Beetle and Its Control.
 1040. Illustrated Poultry Primer.
 1041. Eelworm Disease of Wheat and Its Control.
 1042. Saving Man Labor in Sugar Beet Fields.
 1043. Strawberry Varieties in the United States.
 1044. The City Home Garden.
 1045. Laying out Fields for Tractor Plowing.
 1046. European Corn Borer: A Menace to the Country's Corn Crop.
 1048. Rhodes Grass.
 1050. Handling and Loading Southern New Potatoes.
 1053. Control of Cherry Leaf-Spot.

EMERGENCY OUTSIDE PRINTING.

For emergency printing to make more effective the campaign to increase food production and to conserve the food supply, the department had a special appropriation which included printing, the expenditure of which was placed under the direction of this division. This was in addition to the regular printing fund. As during the preceding year, this emergency appropriation was utilized for the printing and distribution of various bulletins, leaflets, pamphlets, circulars, posters, etc., requiring immediate dissemination.

The expenditures for emergency printing supplied by private printing houses aggregated \$120,158.85.

As heretofore, some of the Farmers' Bulletins were utilized in the department's intensive campaign. There were 61 such bulletins during the year, the editions of which aggregated 2,447,000 copies. Of emergency pamphlets, leaflets, and informational circulars there were 59, and the number of copies issued was 7,295,500; of circulars and folders there were 62, and the editions aggregated 6,309,000 copies; of posters, charts, maps, etc., there were 32, the editions totaling 2,217,020 copies; of Department Bulletins there were 3, and the copies issued 26,000; of miscellaneous labels, forms, maps, etc., the editions aggregated 658,351. The grand total of emergency publications, leaflets, circulars, etc., was 18,952,871 copies.

The printed matter was distributed under the supervision of the assistant in charge of distribution, largely through the department's county and demonstration agents, and other official channels. A

large percentage of the distribution was made directly from the plants of the contracting printers.

The distribution of all emergency printed matter was carefully planned with the view to disseminating it in the locality to which it was adapted and at the time when it was most helpful.

PUBLICATION WORK OF THE WEATHER BUREAU.

A sum not exceeding \$47,000 is allotted to the Weather Bureau from the appropriation for the printing of the department. This money is expended by the Weather Bureau and is not under the supervision of the Division of Publications, but in order to furnish a complete report of the publications of the department the following list is supplied by that bureau:

Weather Bureau publications, issued during the fiscal year 1919, at Washington, D. C.

	Total number of copies.
Instructions to Cooperative Observers (Instrument Division Circulars B and C combined).....	5,000
Daily River Stages at river-gage stations on the principal rivers of the United States, for the year 1917; Vol. XV.....	675
Monthly Weather Review; May, 1918, to March, 1919, 11 numbers.....	16,475
Index and title-page for Vol. 46, Monthly Weather Review, 1918.....	2,000
Supplements Nos. 10 to 14 (Aerology Nos. 5 to 9), Monthly Weather Review..	7,500
Climatological Data for the United States, by sections, March, 1918, to March, 1919, with annual summary for 1917; 14 numbers.....	4,340
Daily Washington weather maps, first and second editions.....	370,877
National Weather and Crop Bulletin; issued weekly from April to September, and monthly from October to March; 32 numbers.....	112,860
Snow and Ice Bulletin; issued weekly during the winter months; 17 numbers..	19,190
Forecast cards, daily except Sundays and holidays.....	373,243
Weekly forecasts.....	8,415
Monthly Meteorological Summary for Washington, D. C.....	3,280
Total.....	923,855

WORK OF THE DIVISION, BY BRANCHES.

The work of the division during the year has been organized in six branches, charged respectively with printing, editing, indexing, illustrating, distributing, and motion-picture activities. A brief statement regarding the operations of each follows:

PRINTING SECTION.

The printing work included the preparation of manuscripts for the printer, supervising reproductions of illustrations and approving finished work of same, assembling material for transmission to the Government Printing Office, making requisitions for printing and binding, preparing schemes of distribution for publications, keeping records of manuscripts, job work, etc., received for printing and binding, and conducting business relating to the publication and printing and binding work of the department between the various bureaus of the department and the Government Printing Office. The work of this section was directly in charge of the assistant chief, Mr. B. D. Stallings.

The new publications of the department during the year numbered 840, while the reprints of publications for the same period numbered 401, making a total of 1,241 publications, nearly all of which were handled in this section. The following table gives a comparative statement of publications issued in the last 10 years:

New publications and reprints, ten years, 1910 to 1919.

Class.	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
New publications....	1,085	1,170	1,250	1,771	1,152	913	944	1,132	2,205	840
Reprints.....	462	696	648	429	474	393	357	390	341	401
Total	1,547	1,866	1,898	2,200	1,626	1,306	1,301	1,522	2,546	1,241

The volume of miscellaneous printing handled by the section, which includes blank books, circulars, and the general job work of the department, increased greatly during the year. The necessary estimates, calculations, and measurements for this work were carefully revised in this section, including the standardization and modification of sizes for the various printed forms of the different bureaus, the selection of appropriate and economical paper stock, and the elimination of unnecessary operations. This revision resulted in substantial economies, amounting to approximately \$7,000, and a saving of about 14 tons of paper. As practically all of this class of printing and binding is reproduced yearly, many of these economies will be perpetuated.

The proofs of the publications and job work of the department were read in this section. The orders for mimeographic and multigraphic work submitted by the various branches of the department were also considered for the most practical and economical methods of production.

The printing of the Yearbook of the department on a half-tone perfecting press recently installed at the Government Printing Office has resulted in a considerable reduction in the cost of production, with an improvement in the appearance of the publication. Methods of production are contemplated for the coming year which, it is believed, will still further improve the appearance of the Yearbook for 1919 and will result in a material reduction of its cost to the public.

It is also contemplated by the Government Printing Office to employ this rapid half-tone press in the printing of many of the illustrated Farmers' Bulletins. This should, and no doubt will, expedite the issuance of these popular publications and thus contribute to the efficiency of the publication work of the department.

In the course of its work this section examined 100 bids submitted by contractors for furnishing the engravings, lithographs, etc., to be used in illustrating the publications of the department, made recommendations for awarding the contracts for the same, and conducted the correspondence relating thereto. It also procured from the Government Printing Office and from private contractors 50 estimates of cost for maps and reprints of publications of the department desired by cooperating agencies.

EDITORIAL SECTION.

The editing of the manuscripts was done with a small force of assistant editors under the immediate supervision of Mr. W. F. Harding and under the general direction of the Chief of the Division. The work comprised not only the regular publications, but numerous emergency circulars, leaflets, etc., designed to stimulate agriculture and increase crop production. The editorial work had for its principal object the presentation of information in the briefest, most attractive, and most economical form.

In addition to the 840 new publications issued during the year, a number of manuscripts were edited and prepared for the printer, but not published because of insufficient funds, while others, upon critical examination, were found unsuitable for publication.

The editorial work upon manuscripts is done with a view to adapting them to the series of publications in which they are to be issued. The contributing bureaus and authors are freely consulted, with the purpose of insuring accuracy in the statements made and with the object of adopting the most desirable and convincing form of presenting the subject matter of the publication. The aim has been to condense the publications to the briefest possible limits. Many of the bulletins issued during the year have been reduced in number of pages at least 25 per cent, and no bulletin exceeding 100 pages was issued. Desirable as this policy is from the point of view of effectiveness of the publications, it is practically forced upon the department by the limitations of the printing fund and the rising cost of printing.

During the year a new series of publications known as Department Circulars was inaugurated to take the place of various unnumbered circulars heretofore issued by the different bureaus. Twenty-two of these circulars were issued during the year.

The new hand-lettered title pages for the Farmers' Bulletins, commenced in 1918, have been continued during the year, and the marked improvement in the appearance of these bulletins has been generally commended.

Both the printing and editorial work of the division were under the general supervision of Assistant Secretary Clarence Ousley, in charge of all publication activities of the department.

INDEXING SECTION.

The work of the Indexing Section consists chiefly in the preparation of detailed card indexes of department publications as issued. This work was advanced and notably improved during the year. Indexes for individual publications are also made to be printed with the publications.

Under present methods, when Farmers' Bulletins and Department Bulletins are indexed for the card indexes, duplicate cards are written. These duplicates have proved so satisfactory for use in compiling indexes for bound volumes that the indexes for bound volumes of Farmers' Bulletins have been brought very nearly up to date, while the indexes for bound volumes of the Department Bulletins are being advanced. During the greater part of the year this work was badly crippled for lack of copyists to make card copies of entries for card indexes, but the copying of cards is now moving forward rapidly.

Indexes were made as usual for the Yearbook, for the Annual Report of the Department of Agriculture, for committee hearings, and for the List of Workers in Subjects Pertaining to Agriculture and Home Economics.

The preparation of a cumulated index for the first 1,000 Farmers' Bulletins has been taken up and is being pushed vigorously, with the expectation that it will be in the printer's hands within a few weeks. The list of Publications Available for Distribution, which is revised each year, also is about ready for the entries of publications issued in June, 1919, and it is hoped to have the revision ready within 10 days after the Farmers' Bulletin index is ready.

The increase of work here with the rapid growth of the department and increase of its publications emphasizes the recommendation repeated annually for several years that another indexer be added to the office force. This will be necessary if the indexing deemed to be absolutely current and essential is to be kept nearly up to date. Two indexers and a compiler added to the force would make it possible to take up indexing long held in abeyance.

The demand for lists of references from the indexes in the Indexing Section has increased notably in the year; but it is still true that it is not sufficiently known throughout the department that these indexes exist. It would be desirable to adopt some plan which would put the information offered by the indexes more certainly and attractively at the disposal of all department officials.

The work of this section in the fiscal year included writing 45,000 index cards; making 100,000 copies of the same; alphabetizing; filing a part of the cards; and distributing another part to other offices that use them.

The indexing work of this section for the fiscal year involved the indexing of 27,640 pages of department publications, and 11,976 pages of the Congressional Record.

The Indexing Section was under the immediate supervision of Mr. C. H. Greathouse.

ILLUSTRATION SECTION.

The drawings prepared by the draftsmen during the year numbered 1,760, compared with 2,483 during the preceding year.

Though the number of drawings made shows a falling off, the actual amount and quality of the work produced was greater, as the efforts of the artist-draftsmen were concentrated on the designing of special cover pages to enhance the attractiveness of publications, and the creation of colored posters used in special educational campaigns. As a result, requests for hundreds of simpler drawings had to be canceled owing to the limited force of draftsmen.

The growth of the photographic work shown in last year's report has continued, with no increase of force, the total output showing 181,006 pieces as against 172,066 in the preceding year.

One hundred and fifty-six requests for photographs were received from persons outside the department, for which a total of \$621.62 was collected and turned over to the Division of Accounts and Disbursements.

Eighty-eight requests were received for duplicates of cuts used in illustrating the department's publications and 818 cuts were taken from the files and sent to electrotypers, who furnished duplicates to the applicants at their expense, the original cuts being afterwards returned to the files.

Summary of the photographic work done during the year ending June 30, 1919.

Photostat prints.....	15,684
Contact prints.....	116,644
Negatives.....	6,148
Developing.....	4,290
Lantern slides.....	26,991
Lantern slides colored.....	88
Bromide enlargements.....	4,697
Bromide enlargements colored.....	255
Solar bromides.....	517
Maps and prints mounted.....	5,692
Total.....	181,006

The output of the Illustration Section is primarily intended to illustrate reports of investigations conducted by the scientific staff of the department, and must be of the highest order, and unless a readjustment of salaries is effected in the near future, the work of the section will be greatly hampered through the scarcity of technically trained men willing to accept the low entrance salary offered. A number of the best artists and photographers have left the service within the last two years to accept more lucrative positions in the commercial field, and while the section has been fortunate in the possession of an "esprit de corps" which has held the force together to a great extent, the allurements of the greatly advanced scale of remuneration paid elsewhere will disrupt the force unless adequate salaries are provided.

The drafting and photographing work continued under the immediate supervision of Mr. A. B. Boettcher.

DISTRIBUTION SECTION.**TOTAL DISTRIBUTION OF PUBLICATIONS.**

On July 1, 1918, 12,184,304 copies of department publications were on hand for distribution. During the fiscal year ending June 30, 1919, 61,240,852 copies of publications were received (including publications charged to the food production act and certain acts administered by the department), making a total stock for distribution of 73,425,156 copies. This included all classes of publications—Department Bulletins, Farmers' Bulletins, Department Circulars, unnumbered leaflets, Farmers' Bulletin lists, and press notices. During the year from this stock 62,218,829 publications were distributed, leaving a balance on hand July 1, 1919, of 11,206,327. This distribution was classed under the following heads:

Miscellaneous publications (Department Bulletins, Department Circulars, reports, etc.).....	40,354,810
Farmers' Bulletins.....	17,159,294
Farmers' Bulletin lists.....	3,280,000
Press notices.....	1,424,725

Compared with the total distribution for the fiscal year ending June 30, 1918, which aggregated 99,222,321, the distribution for the past year shows a considerable reduction, due to the suspension of war activities.

MISCELLANEOUS DISTRIBUTION.

The major portion of this distribution was of the miscellaneous publications, 40,354,810 of which were distributed. By far the greater part of this class of publications was distributed in accordance with carefully prepared schemes of distribution arranged in advance of

the issuance of each publication. Part of this method of distribution includes the sending in liberal quantities to county agents the publications adapted for distribution in their districts. It was in this class of publications that the greatest falling off in the number distributed occurred, as 24,943,456 less were sent out than the year previous.

CONGRESSIONAL DISTRIBUTION.

The Farmers' Bulletins were not called for in as great quantity as the year before, although 17,159,294 copies were distributed. Of this number 5,490,652 were distributed on orders from Members of Congress and the remaining 11,668,642 were distributed by the department. Included in the department's distribution were 1,118,000 sent according to the regular schemes of distribution; 7,168,495 were forwarded upon orders issued by various offices of the department, and 3,382,147 were sent in response to requests from miscellaneous applicants. In addition to the Farmers' Bulletins, Members of Congress were furnished with 3,280,000 lists of Farmers' Bulletins which were used by the Members in distributing their allotments of Farmers' Bulletins. The aggregate number of Farmers' Bulletins distributed during the fiscal year ending June 30 was much less than during the year 1918, which is the reason that it is possible to carry over 9,009,127 to be distributed during the current fiscal year.

The distribution work involves the keeping of records of the distribution of the thousands of publications carried in stock; correspondence with Members of Congress, officials of States and counties, department officials, and the general public; the maintenance of mechanical labor-saving devices, such as folding, stencil, and bundling machines, etc.; the keeping of foreign mail records; and furnishing information regarding publications to visitors who call at the office.

In conducting the distribution directed by Members of Congress 28,235 letters were received, and 25,053 orders were issued on the Superintendent of Documents, Government Printing Office.

In many cases the decision as to what is to be sent devolves upon this office. Millions of Congressional franks are counted. Totals are checked on Farmers' Bulletin lists returned by constituents of Members of Congress. As an account is kept with each Member of Congress, this work must be performed with great accuracy.

In connection with this work 44,883 letters were prepared during the year. Of this total 6,875 were dictated; 12,060 were composed by the typist or stenographer, in accordance with general instructions; 22,359 were form letters; and 3,589 were reference slips. There were also cut 1,374 dermatype stencils.

CORRESPONDENCE UNIT.

Daily several thousand requests are received from applicants from various parts of the country for information on many phases of agriculture. These requests are largely the result of the issuance of the Monthly List of Publications and the publicity given the activities of the department by the Office of Information. During the year just closed miscellaneous requests for publications and other information were received from 491,567 applicants. After this mail matter had been sorted into classes, 124,583 orders were issued on the Superintendent of Documents for miscellaneous pub-

lications and 377,127 orders for Farmers' Bulletins. More than 16,609 forms and postal cards were used in acknowledging requests, and 32,940 requests were referred to proper offices for further attention. A "correspondence unit" of 27 clerks was required to keep this work up-to-date. During the year 26,800 entries were made in an index of addresses to which the last edition of the Yearbook were sent. In cooperating with other bureaus 22,283 addresses were written. The correspondence work, as heretofore, is in charge of Mr. John O. Riley, who by reason of his long experience with Government publications is especially fitted for the work.

WORK OF THE MACHINE ROOM.

The duplicating, addressing, receiving, folding, and shipping units of the distribution work during the year were under the immediate supervision of Mr. Clarence E. Bracey. During the year the work of these various groups was exceedingly large. The duplicating unit cooperated with 26 offices in the department, and completed 2,675 jobs, comprising 2,265,641 pages, of which 3,840,221 copies were printed. This great number of copies was printed from 18,031 pages of type. The number of copies was considerably greater than in the preceding year.

At present mailing lists are maintained for 16 bureaus and offices of the department, aggregating 268,775 individual addresses. Maintaining these lists involves the cutting of stencils, the removal of stencils containing addresses, the actual addressing of envelopes and franks, and the cutting of congressional franks and paper for various bureaus of the department, the making of memorandum pads, the folding of circulars, and the assembling and stapling of matter duplicated.

RECEIPT AND DISPOSITION OF PRINTED MATTER.

During the year accurate records have been kept of the publications and job work received and turned over to the proper distributing offices. Deliveries made to this office aggregated 52,080, comprising 19,758 packages of publications and 41,636 packages of job work. The receiving, storing, and redespaching of this matter was a task the magnitude of which can hardly be realized by those not actually engaged in the work. This work was rapidly and efficiently done without any serious error or mistake, although the employee in charge of it was handicapped at times, owing to the lack of storage space and platform facilities.

MAILING LIST RECORD WORK.

Closely related to the mailing and folding room work is the work of maintaining a record of the various mailing lists of the department. These mailing lists are separated broadly into two classes, those for which the mechanical equipment is maintained in this office, and those that are maintained at the office of the Superintendent of Documents. The aggregate number of individual addresses is approximately 496,450. This work involves the adding, dropping, and changing of addresses on the mailing lists; the transmitting of such additions and changes to the office of the Superintendent of Documents; the distribution of proof cards from that official to the different bureaus in the department; the maintenance of a general index of addresses on all mailing lists; the preparation of correspond-

ence incident to such work, and the revision of the individual mailing lists. This work was done under the immediate supervision of Mrs. M. E. Thorn.

FOREIGN MAIL.

During the year 78,630 packages of foreign mail, weighing 22,812 pounds and 10 ounces, requiring an expenditure of \$1,825.01, were sent under postage from this division, and 3,844 packages, weighing 1,430 pounds and 10 ounces, requiring an expenditure of \$64.42, were shipped through the Smithsonian Exchange. The total expenditure for foreign mail was \$1,889.43.

INFORMATION UNIT.

Beginning with July 1, 1918, a separate information unit was maintained in the distribution section. A veteran clerk familiar with the work of the division, and possessing a general knowledge of the work and policy of the department, was placed in charge. The office was supplied with a general card index of the department's publications and with catalogues, lists, and indexes necessary to furnish information to the many visitors constantly calling at this office. During the year 4,028 persons called and received publications requested, or were supplied with information necessary to enable them to secure any other information available in the department. This work should be encouraged and developed.

PERSONNEL.

Commendable cooperation was given during the year by the rank and file of the employees in the distribution section. The spirit shown by them at all times was excellent, particularly during rush periods when they were called upon to extend their efforts. Without such loyal support it would have been impossible to accomplish the great amount of work performed during the past year, for at times the work was greatly handicapped by "turnover" among certain units of the force, 120 changes having occurred in this division. The greater part of this "turnover" was in the machine and labor-saving unit, and at times the work was greatly impeded.

The work of the distribution section, particularly the physical work, involving the handling of millions of publications and the operation of numerous electrically driven machines, is greatly hampered for lack of space, and arrangements should be perfected as soon as possible, whereby more room would be allotted to the distribution branch, preferably by the assignment of additional space in the building now occupied. If necessary to provide this space, other units not directly assisting or cooperating with the distribution work may be moved to other quarters.

Owing to the low entrance salary paid to employees it is impossible to secure a desirable or thoroughly efficient class for some lines of work; particularly is this true with regard to typewriters and stenographers. The entrance pay of this grade should be \$1,200, which seems to be the minimum salary in other departments and bureaus.

There are a number of employees occupying important positions who have not been promoted within 3 to 10 years, whose salaries should be increased.

The distribution activities were carried on under the immediate supervision of Mr. Francis J. P. Cleary.

MOTION PICTURE ACTIVITIES.

By July 1, 1918, the motion picture branch, which had been placed under the direction of Mr. Don Carlos Ellis subsequent to our entrance into the war with the Central Powers, was producing and distributing, in this country and abroad, a considerable quantity of films, designed to stimulate agricultural production and food and fuel conservation. After the signing of the armistice the program of production and distribution which was under way was continued for the purpose of helping in the work of reconstruction.

FILM PRODUCTION.

Films were completed during the year on 18 subjects, aggregating 26 reels of finished pictures. The releases were as follows:

	Reels.
The Wichita National Forest and Game Preserve.....	3
The Last Days of the Prairie Dog.....	1
Milk and Honey.....	2
Training Boys for Farm Service.....	1
The Western Cantaloupe Industry.....	1
The Potato Industry in the California Delta Region.....	1
The Leak Disease of Potatoes.....	1
To Feed a Hungry World.....	1
The Red Cross Pig Club.....	1
Feeding America from Its Own Back Yard.....	2
Granite Paving and Curbing.....	3
Citrus Fruit Fumigation.....	2
The Barbarous Barbary.....	1
Dust Explosions in Thrashing Machines.....	2
Camera Hunting on the National Forests.....	1
Vacation Days on the National Forests.....	1
The Charge of the Tick Brigade.....	1
Grading Wheat Under Federal Supervision.....	1

All but one of these films were prepared in the motion picture laboratory of this department. Not only has the output of the laboratory been greatly increased, but the quality of films has been noticeably improved.

Other films in preparation, for which the camera work was completed during the year, are as follows:

Selecting a Laying Hen.	Sheep on the Farm.
Wheat Harvesting and Marketing.	Fishing on a National Forest.
Wheat Transportation and Storage.	Building Wooden Ships.
War Work of the Forest Products Laboratory.	Roads and Trails on the National Forests.
Hog Feeding and Housing.	The Columbia River Highway.
Great Breeding Dairy Cattle.	Logging Operations on the National Forests.
Purebred Beef Cattle.	Home Demonstration Work.
Building a Summer Home on a National Forest.	Draft Horses.
	Control of the White Pine Blister Rust.

A small amount of printing was done of films to be used in Liberty loan campaigns.

FILM DISTRIBUTION.

On June 30, 1919, 244 reels of positive film of 57 subjects were available for distribution. During the year these were circulated through the extension services of this department and of the State colleges of agriculture, at State and other fairs and expositions, churches, schools and other educational institutions, at farmers' meetings

and elsewhere, and through the military and naval camps and hospitals in this country and abroad. Prints of negatives furnished by this department were, without cost to the department, made and distributed by the Committee on Public Information for exhibition in Europe, by the National War Work Council of the Young Men's Christian Association to the United States military and naval forces in this country and abroad, and, through a commercial company under contract, to theaters.

In order to interest the returning soldier in agriculture, with a view either of encouraging men suited to the work to settle upon the land and cultivate it after their return to civil life or of improving agricultural practices among those returning to farm life, and in order to inform them of the work of this department generally, the department arranged for the use of its films in camps both here and abroad.

Five sets of films of this and other departments were exhibited at fairs and expositions in 20 States during the year, in connection with Government exhibit circuits.

It is estimated that between four and five million people saw these films.

A number of miscellaneous sales were made of positive films printed commercially from our negatives, to schools and colleges, museums, trade associations, and foreign governments.

COOPERATION OF MOTION-PICTURE INDUSTRY.

The motion-picture industry generously cooperated in producing and showing, without expense to the department, film conveying important information and in exhibiting slides carrying appeals concerning farm labor problems, the use of cordwood for fuel, and forest fire prevention. Many thousands of people were reached through these means.

PLANS FOR THE ENSUING YEAR.

Since the development of motion-picture work during the fiscal year 1919 was financed in large part from the emergency food production appropriation, which terminated on June 30, 1919, it will be necessary greatly to curtail this work during the fiscal year 1920. It is planned, therefore, to produce pictures only of a few of the most important projects of the department, while endeavoring further to improve their quality and teaching value—in other words, to produce fewer and better films. It will be impossible, with the force and funds available, to approximate meeting the growing demand for the films or to take advantage of the opportunities constantly being presented for their broadcast exhibition. The unsolicited demand for these films from extension workers, farmers and farmers' associations, agricultural and other schools, army camps and hospitals, the Young Men's Christian Association and similar bodies, and from foreign Governments is large and on the increase and can not be properly met. It will be necessary generally to mark time in distribution until provision can be made for its development.

REPORT OF THE CHIEF OF THE BUREAU OF CROP ESTIMATES.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CROP ESTIMATES,
Washington, D. C., October 1, 1919.

SIR: I have the honor to submit herewith the report of the Bureau of Crop Estimates for the fiscal year ended June 30, 1919.

Respectfully,

LEON M. ESTABROOK,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

WAR ORGANIZATION OF THE BUREAU.

The reorganization of the Bureau of Statistics and its change in title to Bureau of Crop Estimates in July, 1914, was coincident with the breaking out of the World War. It is fortunate that this reorganization was effected at that time, as the war, even before the United States took an active part in it, stimulated the demand for crop and live-stock estimates, estimates of surplus and deficiency of food and feed supply, consumption requirements, exports and imports of the United States and foreign countries, which the bureau could not have met with the old organization. The most important change involved in the reorganization of the bureau and the one which resulted in greatest improvement in the crop-reporting service was the appointment of trained field agents, one for each State or group of smaller States; who were in most cases legal residents of the States to which they were assigned, and whose interests were therefore closely identified with those of the people of the States in which their work is carried on, who travel over their States monthly during the crop season, personally observing and inspecting crops, interviewing the best informed men and enlisting their active cooperation in observing and reporting upon conditions for the monthly crop reports.

By the time the United States entered the war, in April, 1917, these field agents had become thoroughly familiar with local conditions and sources of information in their States, so that when the necessity arose during the war emergency for obtaining dependable information quickly concerning present and prospective food supply, or any phase of crop and live-stock production for the use of the administrative officials of the Federal Government, it could readily be obtained

within a few hours or days upon telegraphic request to the field agents. These requests, many of them urgent and without precedent, often involved an enormous amount of work on the part of the field agents, requiring them to work at all hours of the day and night, regardless of Sundays and holidays, but in every case they responded without complaint or hesitation, working conscientiously, efficiently, and loyally to do their part to help win the war. The same is true of the crop specialists, who are assigned to particular crops and collect information regarding their special crops wherever grown, without regard to State lines.

Not only did the war emergency develop the organization of the bureau to a high degree of efficiency of service, but it greatly stimulated the interest and zeal of the vast number of voluntary crop reporters, who serve without compensation. These men reported to the bureau on crop and live-stock conditions and in response to numerous special inquiries more conscientiously and with greater regularity during the war than before the emergency arose. In fact, one of the most inspiring features of our participation in this war was the universal readiness of every man, regardless of his situation in life, to contribute his time, thought, energy, and money, or make any other sacrifice required to help his country win the war against the common enemy.

On June 30, 1919, the bureau had 129 employees in the Washington office, and in the field 12 crop specialists, 39 field agents, and 50 clerks, or a total of 230 salaried employees.

The total number of voluntary crop reporters was 215,460, classified as follows:

Voluntary crop reporters.

List.	1919	List.	1919
Township.....	34,600	Potato.....	5,700
County.....	2,717	Sheep.....	6,446
County aids (estimated).....	5,434	Maple sirup.....	2,017
Field aids.....	25,042	Truck.....	10,000
Special price.....	7,664	Apple.....	9,500
Live stock.....	16,000	Peach.....	3,500
Mill and elevator.....	22,000	Rice.....	500
Individual farm.....	50,000	Tobacco.....	300
Special cotton.....	4,514	Pear.....	2,500
Cotton specialist.....	1,002		
Honeybee.....	5,964	Total.....	215,460

¹ Exclusive of peanut, broom corn, bean, cranberry, and other special lists maintained by field agents.

For the fiscal year ended June 30, 1919, there was available \$346,232 from the annual appropriation and \$117,040 allotted from the war-emergency food-production appropriation, or a total of \$463,272.

WORK ACCOMPLISHED.

During the fiscal year ended June 30, 1919, the bureau issued the regular monthly crop reports, showing estimated acreages planted, growing conditions, yields per acre, and total production, farm prices of different crops for each State and the United States, estimates of total number of live stock of different classes on farms and ranges, their condition, and losses from diseases and other causes. Con-

mercial estimates of the apple and peach crops were made, and the weekly truck-crop news service was continued and extended. Many special inquiries were made during the year, including:

- Quantity of commercial fertilizers used per acre of cotton and proportion of fields upon which used.

- Percentage of various crops to which commercial fertilizer and manure was applied and quantity used per acre.

- Binder twine requirements for the grain crops of 1918 for the use of the Grain Corporation.

- Emergency live-stock survey, to determine the number on farms July 1, 1918.

- Uses made of wheat crop, for the United States Food Administration.

- Quantities of various crops fed to different classes of live stock.

- Live-stock survey of January, 1919.

- Fertilizer inquiry of January, 1919, to ascertain quantity of commercial fertilizers and manure used for various crops.

- Wages of farm help.

- Prices farmers pay for equipment, machinery, and supplies.

- Percentage of farm labor requirements available.

Field agents prepared estimates of acreage, yield, production, and stocks on farms of wheat and corn by counties for the United States Grain Corporation, and they also prepared estimates of the value of agricultural production by counties in each of the principal States for the use of the Treasury Department. Field agents cooperated with officials of the Department of Agriculture, the Treasury Department, and the State extension services in the States where seed-grain loans were made to farmers in the drought-stricken regions of the Northwest and the Southwest in the fall of 1918 and spring of 1919.

The bureau compiled innumerable statements showing the production, consumption, surplus and deficiency, exports and imports, and prices of important agricultural products for all the principal countries before the war, and of production and requirements during the war, for the information of administrative officials of the Department of Agriculture, of other Federal departments, and various war-emergency organizations. Many of these statements were for the use of the department committee on crop production and were used as a basis for the crop-production programs which were recommended. Other compilations were made for the confidential use of the War Trade Board and for the Committees on Agriculture in Congress.

Summaries of weekly reports of the State field agents of the bureau were furnished for the confidential information of the Secretary and chiefs of bureaus of the Department of Agriculture, and after the signing of the armistice the mailing list for these summaries was extended to include other Government officials and Senators and Members of the House of Representatives. Bimonthly foreign-crop reports were issued in the spring of 1919 and will be continued.

A vast amount of information was compiled and furnished in response to inquiries received by telephone, telegraph, letter, or personal call of representatives of the Food Administration, the War Trade Board, the War Industries Board, the Military Intelligence Office of the War Department, the Tariff Commission, the Federal Trade Commission, the Council of National Defense, other departments of the Federal and State Governments, Congress, and private individuals. The statistical library of the bureau was in constant use by such representatives. The limited clerical force of the bureau was taxed to the utmost in compiling and tabulating statements and furnishing information urgently needed for immediate use.

More than 4,000,000 pieces of mail were handled by the Division of Crop Reports during the year, as compared with 3,200,000 by the same division for the preceding fiscal year, an increase of 25 per cent. About the same relative increase was noted in all other branches of the bureau at Washington.

In the State offices of field agents the work more than doubled in the fiscal year 1919 as compared with the preceding year. The issuance by field agents of monthly State crop reports bearing their names which are generally reproduced in all the State papers has made them widely known throughout their States and has resulted in a heavy volume of correspondence. Many of the field agents are becoming more and more recognized among business men and

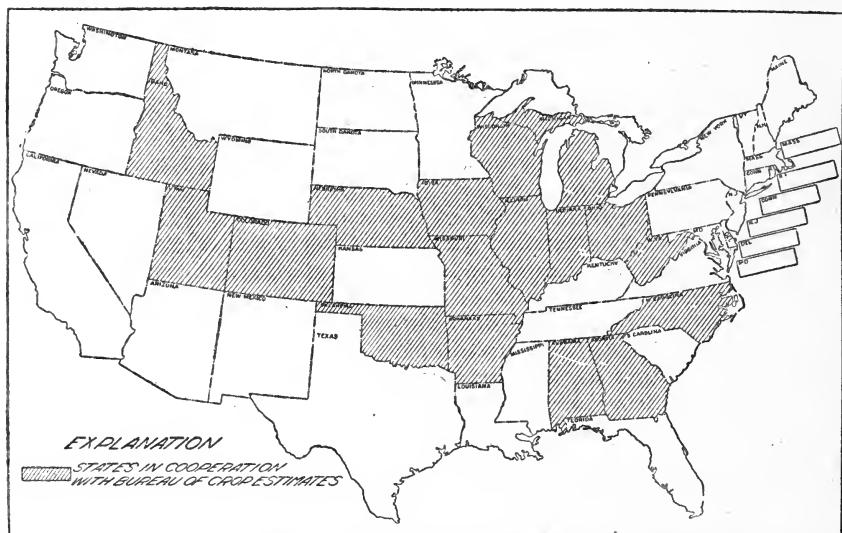


FIG. 1.—The shading indicates States cooperating under formal agreements with the Federal Bureau of Crop Estimates in the collection and dissemination of monthly estimates relating to crops and live stock.

Cooperative agreements are under consideration in several States not shaded in the above map, and partial cooperation exists in some others as a result of mutual interest.

officials of the State governments and State institutions as the best authorities on the statistics of agriculture in their States, so that the practice is growing of referring correspondence calling for statistical information to the field agent of the Bureau of Crop Estimates. A considerable number of requests for information regarding localized production within a State, such as special crops or county estimates, are regularly referred by the Washington office of the bureau to the State offices of field agents. The steadily increasing demand for detailed information which can be furnished only by the State field agents indicates the need for providing them with adequate office space, equipment, and clerical assistance.

COOPERATION WITH STATE DEPARTMENTS OF AGRICULTURE.

During the fiscal year just closed cooperative agreements were entered into between the Bureau of Crop Estimates and the State

departments of agriculture of Arkansas, Georgia, Alabama, North Carolina, West Virginia, Illinois, Iowa, Oklahoma, and Idaho. These agreements provided for pooling the crop reporting resources of the two organizations and the issuance of a single cooperative monthly State crop report in order to avoid unnecessary duplication of work and expense and to improve the service. This plan of combining the force and funds of the bureau with those of State departments of agriculture has proved highly satisfactory in all States in which it has been tried. The shaded portions of figure 1 show the States with which the bureau is now cooperating.

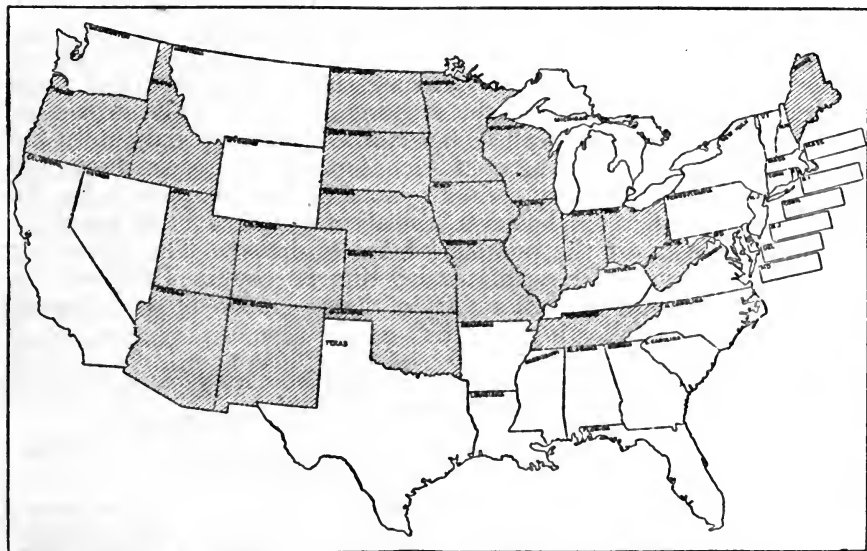


FIG. 2.—The shaded portion indicates States requiring assessors to gather agricultural statistics from farmers annually, including generally acreages planted to specific crops, numbers of bearing fruit trees, numbers of live stock, and other statistical information relating to agriculture. This information has no bearing on taxes, but is of the utmost value to the State and Federal agricultural authorities, not only as a basis for accurate monthly crop estimates for the information of producers and business men, but in agricultural and marketing plans of which such information must necessarily form the base. In addition to the States shaded, which have laws for the collection of statistics by assessors, North Carolina assessors are proceeding to gather the information in advance of the enactment of such a law. Florida has legislation providing for biennial censuses. In practically all States the tax assessors make an annual census of live stock.

STATE ASSESSORS' RETURNS.

In a number of States the efficiency and value of assessors in collecting agricultural data of fundamental importance in crop and live-stock estimating, such as acreages planted to different crops and the number of live stock of different classes on all farms within the State, has been fully demonstrated, notably in Wisconsin, Ohio, Nebraska, Iowa, Kansas, and Missouri. The bureau is, therefore, systematically encouraging the use of assessors' returns as a basis of estimating and is cooperating with State officials to see that proper steps are taken to insure that the returns shall be complete and that they shall be properly edited and tabulated so that dependable

results will be available before the final estimates of acreage and production are issued for publication. When so checked for completeness and correctness, assessors' returns of agricultural data, which have no connection whatever with taxation, form an annual census of the greatest value. During the winter and spring months of 1918-19 a number of State legislatures amended old laws or passed new laws providing for the collection of agricultural data by assessors. The States which now have such laws are shown in the shaded portions of figure 2. It is hoped that all States will join in this movement to ascertain accurately the agricultural resources of each county and State annually.

ACCURACY OF THE CROP ESTIMATES.

The value of the crop and live-stock estimates depends upon their accuracy and timeliness, and the amount of detail. The degree of accuracy of the estimates can be determined only approximately for most crops, by checking against such figures as are available for crop movement, receipts at primary markets, and exports. In the case of the cotton crop, however, an absolute check is afforded by the annual census of the number of bales ginned. The following table shows the annual estimates by this bureau in December in comparison with the annual report of bales ginned by the Bureau of the Census the following March:

Annual cotton estimates of the Bureau of Crop Estimates, compared with annual Census reports of cotton ginned.

Crop year.	Pounds of cotton (000 omitted).		Over estimated.	Under estimated.
	Estimated by Department of Agriculture.	Finally reported by Census Bureau.		
			<i>Per cent.</i>	<i>Per cent.</i>
1900-1.....	4,856,738	4,846,471	0.2	.....
1901-2.....	4,529,954	4,550,950	.....	0.5
1902-3.....	5,111,870	5,091,641	.4	.....
1903-4.....	4,889,796	4,716,591	3.7	.....
1904-5.....	6,157,064	6,426,698	.....	4.3
1905-6.....	4,830,217	5,060,200	.....	4.0
1906-7.....	6,001,726	6,354,110	.....	5.5
1907-8.....	5,581,968	5,312,950	5.1	.....
1908-9.....	6,182,970	6,336,070	.....	2.4
1909-10.....	4,826,344	4,783,220	.9	.....
1910-11.....	5,464,597	5,551,790	.....	1.6
1911-12.....	7,121,713	7,506,430	.....	5.1
1912-13.....	6,612,335	6,556,500	.9	.....
1913-14.....	6,542,850	6,772,350	.....	3.4
1914-15.....	7,637,113	7,718,983	.....	1.1
1915-16.....	5,338,588	5,354,406	.....	.3
1916-17.....	5,506,896	5,489,012	.4	.....
1917-18.....	5,237,379	5,406,350	.....	3.0
1918-19.....	5,595,529	5,760,184	.....	3.0
19 years, 1900-1919.....	108,055,647	109,585,903	.....	1.4
5 years, 1914-1919.....	29,315,505	29,719,932	.....	1.4
3 years, 1916-1919.....	16,339,804	16,646,548	.....	1.8

It will be noted that the bureau estimated the cotton crop of 1915 within three-tenths of 1 per cent, the crop of 1916 within five-tenths of 1 per cent, the crop of 1917 within 3.1 per cent, and the crop of

1918 within 2.7 per cent of the final ginning figures. The wider deviation in the estimate of the 1917 crop was due to the price of cotton in the winter of 1917-18, which made it profitable to pick closer than had ever been done before, the picking continuing as late as February and March in some States. The underestimate of 1918 was due to the comparatively mild winter, which made it possible for more bolls to mature than could be foreseen by the growers, and prevailing prices made it profitable to pick all that opened. The practice of harvesting "bolly" cotton—i. e., unopened bolls—has gradually extended throughout the cotton belt because of the demand for cotton and relatively high prices.

In 1918 for the first time the bureau had a fairly complete check on its estimates of wheat production, afforded by the records kept by the United States Grain Corporation. At the close of the fiscal year the Grain Corporation had reported approximately 730,000,000 bushels of wheat received from farms. The 1918 crop as estimated by the bureau was 917,000,000 bushels, with 8,000,000 on hand July 1, 1918, from the previous crop, making a total of 925,000,000 bushels available. Of this amount approximately 105,000,000 bushels were used for seed, 25,000,000 bushels of damaged or inferior grain is normally fed to poultry and other live stock, and after deducting the 730,000,000 reported by the Grain Corporation as marketed from farms, there is left 65,000,000 bushels to be accounted for. It should be remembered that the Grain Corporation gets no reports of wheat ground in mills of small capacity, which includes many small country grist mills in every State in which wheat is grown and consumed locally, the annual capacity of which is far in excess of 65,000,000 bushels. Apparently the bureau underestimated the 1918 wheat crop slightly, perhaps as much as 2 per cent. In all probability the estimates of the United States wheat crop were about as accurate as an agricultural census by ordinary methods.

DEMANDS FOR IMPROVED CROP AND LIVE STOCK REPORTING SERVICE.

The war emergency not only demonstrated the efficiency and the value of the crop-reporting service but also showed the need for improvement to meet continuing demands upon the service, which can only be partially met with the present force and funds. These demands may be classified as follows:

(1) The demand for estimates and forecasts of the consumption, market, export, and import requirements and available surplus of agricultural products, not only in this country but in foreign countries as well. This information is needed as a basis for intelligent planting and marketing programs, the importance of which was fully demonstrated during the war and will continue to be of equal importance in the years to come, as population increases without a corresponding increase in arable land in this country, and as competition develops with foreign countries.

(2) The demand for information in advance of planting time or while planting is in progress as to acreage to be planted to crops, in order that any prospective surplus or deficiency may be equalized by modifying later plantings in accordance with prospective supply and demand. Estimates of farmers' intention to plant were made in

the spring of 1917 and 1918 for the information of the administrative officers of the Government, and came very close to final estimates.

(3) The demand for crop and live-stock estimates by counties. This demand developed prior to the war, and during the war it became more and more insistent. The bureau has realized the desirability of making its estimates by counties as well as by States to meet the growing demand for such information, but has been unable to shift from a State to a county basis (a) because of the time that has elapsed since the last census by counties, during which intervening period great changes have occurred in many States; (b) because of the enormous increase in detailed work involved in changing from estimated totals for 48 States to estimates for nearly 3,000 counties; and (c) because of inadequate funds and force, which would not permit of further expansion of the service. However, during the war period, with such emergency funds as were available, it was found practicable to change more or less completely from a State to a county basis in six States and to make a beginning in a considerable proportion of the others, the change being made in the offices of the field agents for those States. The details of the county estimates are published in the State reports issued by field agents and not in the Monthly Crop Reporter published at Washington. During the present fiscal year all field agents will attempt to collect and tabulate data by counties, so that following the 1920 census the entire system of crop reporting will be on a county basis, if sufficient funds are provided by Congress to enable the bureau to consummate this plan. County estimates localize crop and live-stock data so as to be of more practical use than mere State totals, and such localization tends to increase the accuracy of the reports. They show the agricultural resources and production of each county, as well as surplus and deficiency of supply; equalize distribution; facilitate marketing; enable transportation companies to supply cars needed for moving surplus crops, and manufacturers and merchants to provide farm machinery and supplies when and where needed; and form the basis of much of the constructive work of the agricultural colleges and county agents.

(4) The demand for "commercial" crop and live-stock estimates, i. e., estimates of marketable farm surpluses, which is the portion of the crop that is sold from the farm, enters the channels of trade, becomes a part of the visible supply, and influences prices, has also developed to a point where provision should be made for supplying it. For half a century the bureau has been estimating total crop and live-stock production, which includes not only the portions of the crops which are marketed, but the portions which are fed, consumed, damaged, lost, wasted, or utilized in various ways on the farm. It is necessary that total production should continue to be estimated, because it is the basis of commercial production, the proportion of the total which is marketed varying with market demands and prices. On the other hand, it is the commercial production or marketable surplus which makes up the commercial or visible supply and in which producers, consumers, and distributors are alike interested. Dependable information concerning commercial production of farm commodities is essential to any enlarged program of market-

ing. To meet partially the demand for estimates of commercial production, the bureau has at various times estimated the percentage of total production of certain crops in each State that is marketed for each month of the year. In the case of apples, peaches, and truck crops, these estimates have been published in terms of bushels, barrels, crates, or car lots. In the spring of 1919 a program was prepared for estimating the commercial production of the late crop of white potatoes. Commercial estimates involve a rather intensive survey of the principal areas of commercial production, the organization of a special corps of crop reporters, and the employment of crop specialists who are familiar with the industry and can devote their entire time to collecting, summarizing, and interpreting data regarding the particular crops in such form as to be of practical use to growers and to the marketing agencies.

(5) Reserve stocks on farms. A further development of the increased interest in the food supply during the war period has been the demand for information concerning reserve stocks on farms. This is closely related to the demand for information regarding commercial production or marketable surpluses on farms, but it takes the form of requests for information as to the portion of the total marketable surpluses that remains unsold on farms at frequent intervals. This information is essential in connection with estimates of visible supply, that is, stocks of farm products in public and private warehouses, mills and elevators, in transit, and in factories and wholesale establishments. If the bureau were provided with adequate funds, it would be entirely practicable to furnish such estimates monthly. In the past it has been practicable to make such estimates for only a few crops annually. The program for commercial potato estimates provides for estimating stocks of potatoes on farms monthly throughout the year. A similar program should be developed for other crops.

(6) New crops. Much interest was also manifested during the war and since the war in estimates of new crops, or rather crops concerning which dependable data were lacking, such as castor beans, or phases of production, demand for and supply of farm and forest products, such as rosin, turpentine, cotton linters, sorghum sirup, soy beans and velvet beans, and the vegetable oils.

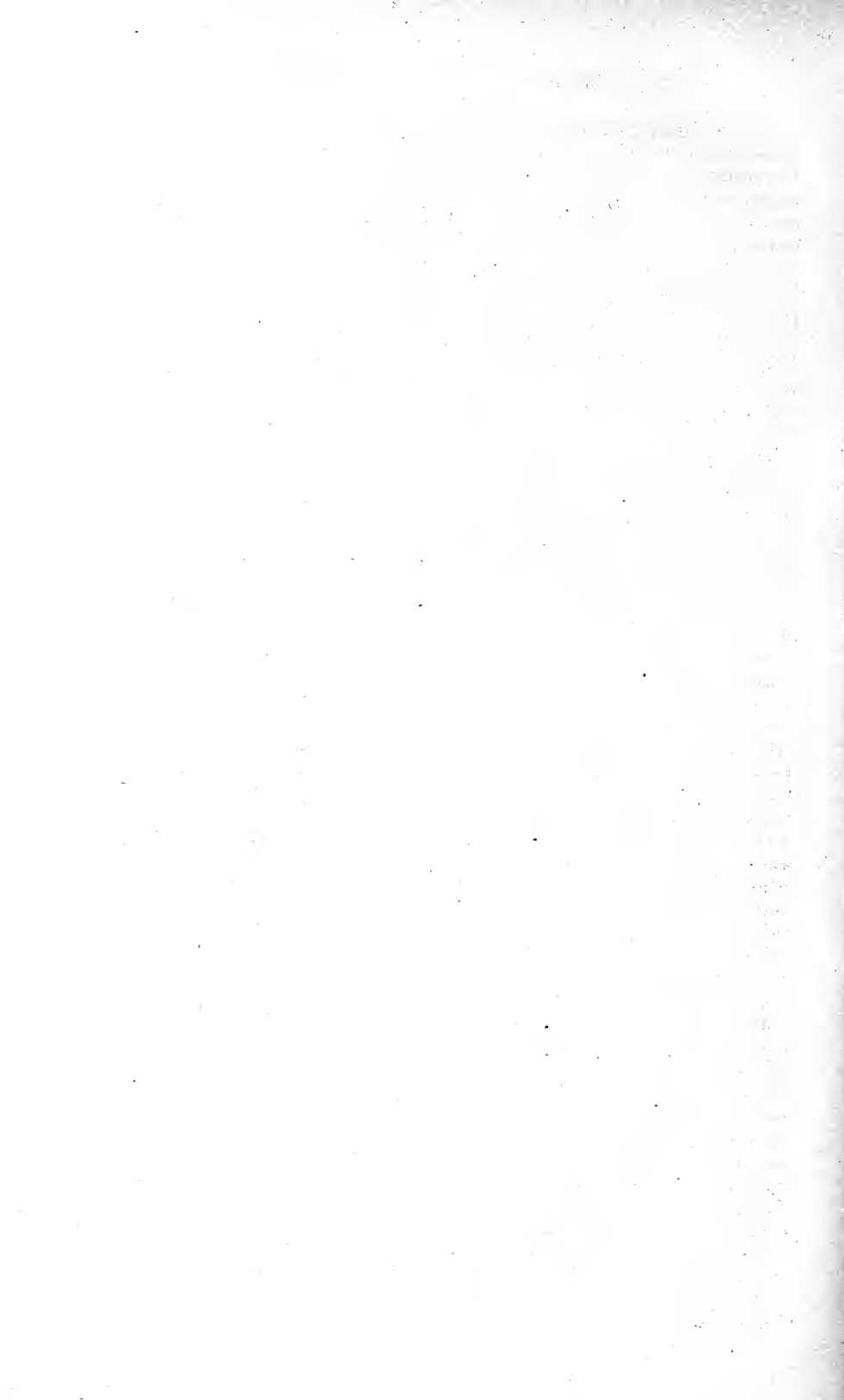
(7) Live stock. No phase of crop estimating has been less satisfactory than the live-stock reporting service by reason of its inadequacy. Because of lack of funds and facilities, these reports have been limited to estimates of the number of animals on farms once a year, the percentage of losses from disease and exposure annually, the condition of live stock on a percentage basis, and the number of brood sows, without any estimates whatever of milk, butter, cheese, poultry and egg production. The live-stock industry is worth approximately \$10,000,000,000, and yet the bureau has had less than \$50,000 available for reporting upon all classes of live stock. The expenditure of \$500,000 annually would be fully justified in furnishing satisfactory monthly reports covering number, condition, age, sex, and breed of different classes of live stock, and of dairy and poultry production, slaughter, losses from disease, insects, exposure, and other causes, farm prices, present and prospective supply of feed, and similar data. Such estimates can be furnished for half the

amount named and would be of untold value to the industry, because definite, detailed, and timely data would be available which would enable growers to decide intelligently upon long-time programs of production, how and when to sell, and how best to take advantage of the feed situation. Such data are also essential to any program of crop production which involves live stock as a part of the farm-management program, and are absolutely necessary as a guide to intelligent marketing and distribution of live stock and live-stock products. With the limited funds at its disposal the bureau has endeavored to meet the increasing demand upon it for live-stock information, with an ever-increasing realization of the inadequacy of the present live-stock reporting service and of the funds and force available for improving the service.

(8) Special phases of agriculture. The war also stimulated interest in special phases of agriculture, and many requests continue to be received for information on farm wages; hours of farm labor; prices farmers receive for their products; prices farmers pay for equipment, machinery, and supplies; progress of farm work; amount of binder twine required; seed requirements, supply, surplus, and deficiency; number of farm tractors; number of silos; storage capacity on farms; average distances farmers must haul products to nearest market or shipping station; kinds and quantities of fertilizers required for different crops and sections of the country; farm income and outgo; extent to which particular varieties of crops are grown and compete with each other; methods of planting, cultivating, and harvesting crops, which are different in different States; utilization of different crops; and similar information bearing on crop and live-stock production as an industry. Requests of this nature are received largely from special investigators employed in other branches of the Department of Agriculture or in the State agricultural colleges and experiment stations, from legislators, representatives of farmers' organizations, and of the press. The bureau was able to furnish much of this information during the war from results of former special inquiries or to secure it from new investigations. With the reduced appropriation available in the present fiscal year it will be impracticable to make additional investigations of this kind.

(9) Foreign crops and live stock. Interest in the foreign crop and live-stock situation during the war was unprecedented in this country. The demand for information concerning consumption, production, import and export of food crops in Europe, and the available supply in countries of surplus production was constant and is continuing. The bureau files of reports from the International Institute of Agriculture and the published and unpublished statistical reports of foreign Governments were consulted almost daily by representatives of other Government departments and war-emergency organizations. Detailed studies were made by specialists of this bureau for the use of economists who accompanied the peace commission to Paris. Estimates of food requirements of foreign countries, their reserve stocks, production and net imports, were essential factors considered by the department's committee which had charge of formulating programs of production in this country during the war. Continued interest in world production and consumption indicates the need for more systematic periodic reports as a guide to production and marketing in this country.

The foregoing indicates some of the principal classes of calls upon the Bureau of Crop Estimates for information in 1917 and 1918. Fortunately the bureau had a highly specialized skeleton organization and through long experience had developed an efficient system for estimating quickly the production and supply of most agricultural commodities in this country and abroad. The additional funds provided out of the war-emergency appropriation for stimulating food production enabled the bureau for the first time to supply the offices of its State field agents with some of the most necessary equipment and with field clerks, without which it would have been impracticable to do more than continue the regular crop estimates on a prewar basis. The war emergency demonstrated the efficiency and value of the crop-reporting service, not only in time of war but still more in time of peace, as an organization for ascertaining and summarizing the essential facts of crop and live-stock production which are necessary for the guidance of farmers, and for the formation of intelligent plans of production and marketing. This service is of such great practical and economic value to agriculture as an industry which is and always will be of fundamental importance in the United States, that the service should be greatly expanded, developed, and specialized in the future.



REPORT OF THE LIBRARIAN.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE LIBRARIAN,
Washington, D. C., September 30, 1919.

SIR: I have the honor to submit herewith the executive report of the Library for the fiscal year ended June 30, 1919.

Respectfully,

CLARIBEL R. BARNETT, *Librarian.*

Hon. D. F. HOUSTON,
Secretary of Agriculture.

SUMMARY.

A glance over the tables of miscellaneous statistics of the Library for the years 1909 to 1919, given in the table in Appendix 1, will show the effect of the European war on the development of the Library in so far as this can be shown by statistics. Up to the fiscal year 1916 there was a steady gain in the use of the Library and in its growth. Since 1916 there has been a decrease each year in the circulation and in the number of accessions, aside from current periodicals, of which the number received has increased in the last two years. The decrease in the accessions has been due to several reasons. In the first place, there have been great difficulties in the way of getting books from foreign countries both by purchase and exchange. In the second place, books published in the United States have been raised in price, and as a consequence not as many books could be purchased for the money available. Many periodicals, too, have raised their subscription prices. And, finally, all supplies needed by the Library have cost more, which has cut down the amount of money available for the purchase of books. An indirect reason for the decrease in accessions has been the loss of many trained assistants since the war, which has interfered with the routine work of obtaining exchanges. Last year the main Library lost half of its staff and the year before nearly as many. It is scarcely necessary to point out the serious loss of efficiency involved in so many changes. In a library such as this, length of service is a greater asset even than it is in most libraries, for familiarity with the Department and with the scientific literature relating to agriculture is necessary before an assistant can do effective work. This familiarity can be gained only through length of service. The principal reason for the loss of so large a number of assistants from the main Library staff has been low salaries. Owing to certain fortunate circumstances the salaries of the librarians and library assistants of the bureau, division, and office libraries are considerably higher than those of the main Library, the average salary being

\$300 higher than the average salary in the main Library. As a consequence there have been few changes in the technical staff of the bureau libraries.

On account of the handicaps under which the Library has labored during the year, the following detailed reports show in nearly every branch of the work a decreased output. The number of books catalogued was far below the number catalogued in previous years and the number of books bound, though slightly in excess of the number for the previous year, was only half the number bound in the fiscal year 1917. The decrease in circulation reflects the interruption in the scientific work of the Department due to the war. But in spite of the setbacks of the past two or three years, as a result of which the statistics of output show decreases instead of increases, there have nevertheless been certain intangible gains which help to make good the losses. The reference use of the Library has increased and the value of the Library's collections has been made known to a wider clientele through the service which it rendered to the new Government offices created since the war. Without the use of our collections many of the investigations which it was necessary for these offices to make would have been severely hampered, as the Library had files which were available in no other library in the city and in few libraries of the country. The statistical reports and journals of various kinds were in especial demand, and the collection of these publications as a whole frequently brought forth words of commendation. The Library's unusual resources along scientific lines and its bibliographical equipment have also been complimented.

But while the Library's collections on the subjects relating to the work of the Department are extensive, they still leave much to be desired. The Department, with its appropriation of \$27,875,353 and its scientific force, which is larger than that connected with any other Government institution, occupies a commanding position in the scientific world and has a large duty to the country. The Library of the Department should occupy the same commanding position in its special field of work and should, by reason of the completeness of its collections and the scope of its service, be able to perform the duties of this position. The growth of the Library's appropriations in the past has not kept pace with the growth of the Department. Now that normal conditions are approaching it is hoped that the development of the Library may be accelerated and that in addition the time will not be long distant when permanent, suitable, safe, and adequate quarters will be provided for the Library's invaluable collections.

REFERENCE AND CIRCULATION DIVISIONS.

MISS EMMA B. HAWKS, *Assistant Librarian*, in general charge.

MISS GERTRUDE E. UPTON, *Loan Desk Assistant*.

The statistics of circulation given in Appendix 2 show that the total recorded circulation of the main Library and the bureau, division, and office libraries for the past year was 68,393 books and pamphlets and approximately 150,000 current periodicals, which was a decrease of 8,000 books as compared with the previous year but a small increase in the number of current periodicals circulated. In

connection with these statistics it should be explained, however, that they represent only approximately the use of the Library, as no circulation statistics are kept in several of the branch libraries and no record of the reference use is kept in any of the libraries.

The average number of books charged at the loan desk of the main Library each month was 3,038, compared with 3,370 in the previous year. The average daily circulation was 120, compared with 132 in the previous year. A table showing the circulation statistics of the main Library by months and years for the last 10 fiscal years, exclusive of the circulation of current periodicals, is given in Appendix 3. From this statement it will be seen that the highest peak in the circulation was reached in the fiscal year 1916 and that there has been a decline of 25 per cent in the last three years due to war conditions and the consequent interruption of much of the scientific work of the Department. While the table gives only the circulation statistics of the main Library, most of the reports of the branch libraries show the same relative decrease in circulation since the war.

INTERLIBRARY LOANS.

The number of books lent to libraries, institutions, and individuals outside of the city was 658, a decrease of 235 compared with the previous year, likewise due to war conditions. To the total number of books lent should be added 145 photostat copies and 14 typewritten copies, making the total use outside of the city 820.

The number of books borrowed from other libraries in the city was 5,026, an increase of 309 over the number borrowed the previous year. The number of books borrowed from libraries outside of the city was 70, or double the number borrowed the previous year. The largest number borrowed from any one library was 22, borrowed from the Lloyd Library, Cincinnati, Ohio.

Further detailed statistics in regard to interlibrary loans are given in Appendices 4 and 5.

CATALOGUE AND ORDER DIVISION.

MISS HELEN M. THOMPSON, *Chief.*

ACCESSIONS.

The total number of catalogued books, pamphlets, and maps added to the Library during the year was 6,045, a decrease of 1,778 compared with the catalogued accessions of the previous year. To the 6,045 catalogued accessions should, however, be added 1,554 books, pamphlets, and maps which were acquired during the year but not catalogued, making the total accessions 7,599, a decrease of 635 compared with the previous year. This decrease was due to the continued difficulty in obtaining books and periodicals from foreign countries, including exchanges, as well as purchases, to the decreased number of volumes acquired by binding periodicals, and, lastly, to the fact that it has not been possible to spend as much time in the work of acquiring exchanges on account of lack of assistance. More detailed statistics of the accessions of the year compared with previous years are given in Appendix 6.

According to the record of accessions, the total number of books and pamphlets accessioned by the Library up to July 1, 1919, was 156,648. From this number should be deducted 5,910 volumes which were discarded during the fiscal year 1915 and 589 which were discarded in the past four fiscal years, leaving a balance of 150,149 books and pamphlets in the Library on July 1, 1919.

Among the notable purchases of the year were Matthews's *Birds of Australia* and Volume I of Beebe's *Monograph of the Pheasants*. Conditions have not been favorable for acquiring old and rare desiderata, but a few such books have been obtained from England and one shipment from The Hague. Among old herbals the Library has obtained Brunfels (1530-32), Gerarde (1597), a Crüyde-boeck of Dodoens (1563), the *Greate Herball* (1561), and Egenolph's *Plantarum, Arborum, Fruticum, et Herbarum Effigies* (1562). In gardening literature Thomas Hill's *Gardener's Labyrinth* (1577), Miller's *Dictionary*, 6th ed. (1752), and Reid, *The Scots Gardner* (1766), are notable. Other interesting items are John Mitchell's *Dissertatio brevis de Principiis Botanicorum, cum Appendice Plantarum in Virginia Observatarum* (1769)—a photostat copy, Detmer's *Botanische Wanderungen in Brasilien* (1897), and Vigier, *Historia das Plantas de Europa* (Lion, 1718), which is an early version in Portuguese of the "Petit Bauhin."

The Library was the recipient during the year of a large number of volumes, which were formerly the property of the Rhode Island Society for the encouragement of domestic industry. These were presented by the estate of Frederick E. Perkins through Mr. Charles R. Stark, of Providence, R. I.

CATALOGUING AND CLASSIFICATION.

The record of the material classified and catalogued during the year is as follows: 2,020 volumes, 459 pamphlets, 3,549 serials and continuations, and 17 maps and charts, making a total of 6,045, a decrease of 1,778 as compared with the previous year. In addition to the complete cataloguing of the above-mentioned items, author cards were made for 273 pamphlets of less importance and 2,498 "reprints."

There were added to the main (dictionary) catalogue 21,881 cards, and 3,118 were withdrawn, making a net addition of 18,763, a decrease of 3,620 compared with the previous year. The main (dictionary) catalogue now contains approximately 410,000 cards.

The number of titles prepared during the year for printing by the Library of Congress in what is known as the "Agr" series was as follows: Cards for accessions, 512; cards for Department publications, 656; total, 1,168, an increase of 108 over the previous year. The total number of titles prepared by the Library since 1902, in which year the printing of cards was begun, now amounts to 31,266.

The amount of uncatalogued material on hand July 1, 1919, was as follows: 368 volumes, 648 pamphlets, 943 continuations, and 6 maps—a large increase over the previous year, due to the loss of assistants who were experienced in cataloguing.

PERIODICAL DIVISION.

MISS LYDIA K. WILKINS, *Chief.*

The total number of periodicals, exclusive of annuals and serials of infrequent issue, currently received by the Library is now 2,493 titles, of which 604 are received by purchase and 1,889 by gift. The number of new periodicals added during the year was 252, whereas 192 of those listed last year are no longer received, either because they have ceased publication permanently or temporarily or because the subscriptions have been discontinued. The net increase was 60. Many of the periodicals are duplicated from two to six times, making the total number of periodicals handled during the year 3,446, an increase of 18 for the year.

Last year's report included a table showing the various foreign countries from which periodicals are currently received and the number received from each country. This information has been kept up to date on cards and has been of frequent use.

There is an increasing demand for a printed title and subject list of the periodicals currently received by the Library, and it is hoped that such a list may be published in the near future.

In addition to the 2,493 current periodicals appearing not less than four times a year, the Library received 3,554 serials of less frequent issue, such as annual reports, proceedings, and transactions published by institutions and societies, a decrease of 350 compared with the previous year. This decrease was due in part to the difficulty in obtaining publications from foreign countries and in part to the fact that it has not been possible to spend as much time on the work of requesting exchanges.

Through the efforts of the Committee on Importations of the American Library Association, arrangements were made in 1918 whereby American libraries were able to import periodicals from the enemy countries. A considerable number of German periodicals published in 1918 and 1919 which were ordered by this Library are now being received, though many others known to have been published have thus far not been obtained at all. Furthermore, there are gaps in the files ranging from one to more than three years. The work of completing these will be most difficult, and there is grave doubt whether some of the missing issues can ever be replaced, as many of the publications were issued during the war only in limited editions. Moreover, a considerable stock of 1916 and 1917 issues destined for this and other American libraries was destroyed by fire in a warehouse in Leipzig.

DUPLICATES.

While there was no decrease in the number of duplicates received from various sources, it was possible to devote little time to the work of listing and disposing of them. As a consequence only one shipment was sent out during the year. This consisted of eight mail sacks of publications requested by one of the State agricultural college libraries. As explained in previous reports, these duplicates are for the most part publications of national, State, and local governments, publications of societies and institutions, and periodicals, which are sent as gifts and exchanges to various offices of the Depart-

ment and later are turned over to the Library to dispose of. While the work of sorting and listing them consumes a large amount of time, in fact the major part of the time of one assistant when the work is kept up to date, it has, nevertheless, been the policy of the Library to encourage the offices of the Department to send to the Library all the publications which they receive, as otherwise the Library is likely to miss many publications which are needed in its files. In order, however, to reduce unnecessary duplications and the consequent unnecessary work and cost of handling them, the Library is continually working toward that ideal state when all publications, both foreign and domestic, which are regularly received by the Department will be addressed to the Library with the exception of the limited number which, for special reasons, it is an advantage to have sent direct to the offices which use them.

MAILING LISTS AND THE DISTRIBUTION OF DEPARTMENT PUBLICATIONS.

There were 1,594 orders issued on the Division of Publications for the mailing of Department publications which were requested by foreign institutions and officials and by societies and private individuals from whom publications are received in exchange. The work in connection with the distribution of Department publications to foreign countries and to libraries in the United States, including the care of various mailing lists, has been described in detail in previous reports. This work is appropriately assigned to the Library because of its close connection with the work of obtaining exchanges.

BINDING DIVISION.

MISS IDA B. SWART, *Chief*.

During the year only 2,011 volumes were sent to the Government Printing Office for binding and 1,612 volumes laced into temporary binders. The number of pamphlets stapled into temporary binders was 743, about half as many as in the previous year.

Like other divisions of the Library, the binding division has suffered severely from the loss of trained assistants. At the close of the last fiscal year the former chief of the bindery division, who had been in charge of the work for ten years, resigned and it was necessary for her successor, who had had no experience in binding, to take up the work after only two weeks' instruction under the direction of the former chief. The work was further handicapped by the fact that the two assistants who had been in this work for several years had resigned a few months previously, leaving the whole division inexperienced in the work. During a part of the year it was also necessary to have the chief of the division and her assistants attend to other duties. It was therefore especially creditable that in spite of these difficulties there was an increase of 345 in the number of books sent to the bindery as compared with the previous year. The number of books bound was, however, less than half the number that needed to be bound. In addition to the difficulties in connection with the preparation of the books for the bindery, the Library's needs as to binding suffered by reason of the fact that its allotment for binding was greatly curtailed.

The table given in Appendix 1 shows the number of books which have been bound during the last 10 years, and the number of periodicals currently received. From this table it will be seen that the number of books sent to the bindery last year was only slightly in excess of the number sent to the bindery in 1909, though the number bound in 1909 was, owing to certain handicaps that year, 300 less than the number bound in 1908. From 1909 to 1917 the number sent to the bindery had through strenuous efforts been more than doubled, but this gain has been entirely wiped out in the last two years. On the other hand, the number of current periodicals received has increased 25 per cent since 1909. These figures show conclusively the urgent need for a greatly increased allotment for Library binding in order that the current periodicals and other unbound publications may be preserved and made available for convenient use. In order to meet the Library's present needs the number of books bound annually should not be less than 5,000 volumes.

BIBLIOGRAPHY.

No new bibliographical work of special importance was undertaken in the main Library during the year on account of lack of assistance and the consequent difficulty of keeping up to date even the routine work of cataloging. A number of miscellaneous reference lists on various subjects were, however, compiled, largely in connection with correspondence. The various bureau libraries also furnished many lists on their special subjects in connection with correspondence or the special demands of their bureaus.

The librarian of the Bureau of Entomology in January, 1919, was placed in charge of a large and important bibliographical undertaking, namely, the planning and supervision of the index to the literature of American economic entomology, 1915 to 1919, inclusive, a continuation of the index previously compiled in the bureau under the direction of Mr. Nathan Banks, entomological assistant. Among the brief reference lists prepared in the library of the Bureau of Entomology were an address list of State entomologists and a list of entomological societies and journals, with the prices of the journals and the addresses of the editors. Short lists of the new publications received by the Bureau of Entomology library were furnished for the Monthly Letter of the bureau.

The librarian of the Forest Service continued the preparation of the Monthly List of books and articles on forestry indexed in the Forest Service library, which list is published each month in "American Forestry." An appendix to Miss Matthew's bibliography on paper research literature was also prepared and published in the issue of "Paper" for April 30, 1919.

The Bureau of Markets library prepared a mimeographed 1919 supplement to the extensive "Selected List of Publications on the Marketing of Farm Products," compiled by Miss M. E. Griffith, the assistant librarian of the bureau, which was reported upon last year. The supplement, like the original bibliography, is in nine parts, with a total number of 24 typewritten pages.

In the Bureau of Plant Industry library the current literature on phytopathology has continued to be indexed and published currently

in "Phytopathology." After many unavoidable delays the "Check List of the Publications of the Department of Agriculture on Plant Pathology" has been issued in mimeographed form as No. 1 of the new series, entitled "Bibliographical Contributions of the Library of the Department." The list was prepared in the library of the Bureau of Plant Industry. Over 500 requests for the list have been received. A similar list of reports and bulletins on the subject of plant pathology published by other institutions is in preparation. The Library has continued its work in connection with verification and editing of bibliographies contained in publications of the Bureau of Plant Industry and in the Journal of Agricultural Research. Bibliographies in 94 manuscripts were verified and edited during the year. In the fall of 1918 the librarian of the bureau, in cooperation with Miss Atwood, bibliographical assistant of the Office of Economic and Systematic Botany, assisted Dr. H. L. Shantz in organizing his survey of the literature of Africa for the purpose of abstracting material on the natural vegetation and agricultural resources to be used in making maps for "The Inquiry."

The bibliographical work of the Office of Farm Management has been along the same lines as mentioned in previous reports; that is, the preparation of selected lists on the cost of crop production. The lists on cost of wheat, oats, barley, rye, corn, cotton, sugar beets, silage, and milk have been brought up to date, and a limited number are to be mimeographed. The indexing of farm management subject matter is being continued.

Lists of the publications of their respective bureaus or divisions were prepared during the year by the librarians of the Bureau of Entomology, Bureau of Markets, the Dairy Division, and the Office of Farm Management.

Mention has been made in previous reports of the work of Miss Marjorie F. Warner and Miss Alice C. Atwood, bibliographical assistants of the Office of Economic and Systematic Botany of the Bureau of Plant Industry. The project under which they work is called "Bibliographical Investigations in the Interest of Botanical Science." While not connected with the Bureau of Plant Industry library or the main Library, the liberal spirit in which the project was established several years ago under Mr. F. V. Coville, the chief of the office, and has been carried on from year to year, tends to bring it into closer relations with the work of the Bureau of Plant Industry library and the main Library. It therefore seems fitting to give here some extracts from Miss Warner's report on the year's work. The flexibility of the project is a factor of great strength as it not only lends itself readily to many definite cooperative enterprises within the Department but also has large privileges and responsibilities in relations outside the Department.

Following are some extracts from Miss Warner's report:

Our activities of the past year seem to class themselves chiefly under the head of cooperation. First and foremost in importance is progress on the Botanical Catalogue. Practically all periodicals received by the Department, together with a number from the Library of Congress, possibly 500 or 600 journals and reports in all, are examined for botanical articles and information, and possibly 75 per cent of such material included in the catalogue. About the middle of the year the circulation of periodicals formerly maintained by the bureau Library was found to be no longer tenable, and a method was sought to bring the contents of the journals to the notice of the scientists with

a minimum of delay and with less handling of the journals themselves. It was finally decided to mimeograph the current titles indexed for the Botanical Catalogue, and circulate these in lieu of the periodicals, which should themselves be kept on call for a certain time in the periodical room. The first of these lists, covering publications indexed January 31 to February 15, 1919, was issued February 25, and they have since appeared, with some changes in arrangement, every two weeks, apparently forming a pretty satisfactory substitute for the circulation of the journals. Next in importance to the work of indexing and keeping up the main catalogue is probably the assistance on the African section of the Inquiry-Vegetation, made by Col. House's Commission. The literature of African botany and exploration was examined and listed by Miss Atwood, who determined the bibliographic form to be used in connection with abstracts of literature which were made under the direction of Dr. H. L. Shantz.

The additions to the Horticultural Bibliography have been only about 400 entries, fairly divided between modern and early literature. The chief expenditure of labor has been on the subject index, which now covers over three-fourths of the entire list, over half the total of some 11,000 titles being indexed during the year.

While the work on the Index of Illustrations has been necessarily subordinated to some of the more vital emergencies of the year, the index has made excellent progress. Several important recent works have been indexed, as Bonnier's *Flore complète illustrée en couleurs* (1911-), Marloth's *Flora of South Africa* (1913-15), Sim's *Forests and Forest Flora of Cape of Good Hope* (1907), and his *Forest Flora of Portuguese East Africa* (1909). Besides these, as a general rule, works which come up in connection with the African Inquiry have been indexed both for their illustrations and for the Botanical Catalogue as well.

Work on the Depository Catalogue or union list of botanical books based on the set of depository cards received from the Library of Congress has been almost at a standstill, only the current printed cards from the Library of Congress and the John Crerar being added. To get in touch with others interested in similar bibliographical work, notes have been published in the *Gardeners' Chronicle* calling attention to the Horticultural Bibliography carried on under our project (*Gardeners' Chronicle* III, 64: 194-195, Nov. 16, 1918), and on the horticultural literature in the Department Library (l. c. 65: 247, May 24, 1919).

PUBLICATIONS.

The only printed publications issued by the Library during the year were the report of the Library for the fiscal year 1918, a pamphlet of 16 pages, and Library leaflet No. 8, entitled "Home Gardening." The leaflet of four pages, which had an attractive cover design in two colors made by the artist, Miss Gertrude Spaller, contained a list of publications on home gardening and was prepared at the request of the Office of Horticultural and Pomological Investigations to assist in the home gardening campaign. A similar Library leaflet on Dairying and new editions of the earlier Library leaflets on Poultry Raising, Pig Raising, and Sheep Raising were also prepared, but for lack of printing funds could not be published.

"A Check List of the Publications of the Department of Agriculture Relating to Plant Pathology," prepared by the library of the Bureau of Plant Industry, was issued in June, 1919, in multigraphed form as no. 1 of a new series of Bibliographical Contributions of the Library of the Department.

LIBRARY STAFF.

The number of employees carried on the roll of the main Library at the close of the year was 33, with two of the lower positions vacant; the number employed by the bureau, division, and office

libraries was 45. Of the total number, 78, employed in the main Library and the bureau, division, and office libraries, 18 are men and 60 women, divided as follows: 19 in administrative work, including the Librarian of the Department, heads of the divisions in the main Library, and librarians of the bureaus, divisions, and offices; 31 library assistants, 12 clerical assistants, 1 translator, 12 messengers, and 3 charwomen.

During the year this Library, in common with other libraries, suffered the loss of several assistants, among whom should be especially mentioned the heads of two divisions, namely, the chief of the binding division, Miss Fanny L. Parker, who resigned on account of home duties; and the reference librarian, Miss Mary G. Lacy, who resigned to become the agricultural librarian of the Iowa State College, Ames.

In the main Library there were in all 28 resignations during the year. Some positions were vacated two or three times, for in several instances it was possible to make only temporary appointments. Out of the staff of 33 on July 1, 1919, there were only 17 who were on the Library rolls at the beginning of the fiscal year. In other words, we had lost half of our staff. Of the 28 who resigned, 15 were library assistants, 4 clerical assistants, and 9 messengers.

On account of the loss of so many assistants in the main Library, not only during the year but also in the two previous years, there have been greater burdens on the remaining members of the staff. These have been met in a spirit of cheerfulness and loyalty to the Library which has helped greatly to minimize the difficulties. During the influenza epidemic several members of the staff of the main Library and the bureau libraries were granted leave to serve as Red Cross nurses, and other members of the staff spent much of their time and strength out of official hours in helping in the emergency.

In continuation of the Library's policy of offering temporary appointments whenever possible to the librarians or assistants connected with the State agricultural and experiment station libraries who wish to have experience in this Library, one more was added during the year to the list of such appointments, the librarian of the Kentucky Agricultural Experiment Station having been appointed for a period of one month.

The only change in the personnel of the librarians of the bureaus was in the Bureau of Public Roads. The former librarian, Miss Grace Francis, resigned in August, 1918, and was succeeded by Mr. M. A. Hays. One assistant in the Bureau of Plant Industry library and an assistant in the Forest Service library also resigned during the year. The librarian of the Bureau of Plant Industry and the librarian of the Dairy Division were detailed June 15, 1919, for six months to the Joint Congressional Commission on the Reclassification of Salaries.

Library staff meetings have been held each month from December to June. No meetings were held in October and November on account of the influenza epidemic.

The Librarian of the Department visited the Delaware Agricultural Experiment Station in March at the request of the station to advise the librarian of the station in the arrangement of the library.

The annual conference of the American Library Association at Asbury Park in June was attended by the Librarian and 12 other members of the staff. Miss Marjorie F. Warner, bibliographical assistant of the Bureau of Plant Industry, presented a paper entitled "Bibliographical Opportunities in Horticulture" at the meeting of the agricultural libraries section.

The librarian of the department has served since September, 1918, as associate editor of "Special Libraries," representing agricultural and Government libraries. The March, 1919, number was devoted to agricultural libraries and contained four articles by members of the library staff.

BUREAU, DIVISION, AND OFFICE LIBRARIES.

It is regretted that from lack of space it is impossible to publish the full reports of the bureau, division, and office libraries. The table giving certain statistics with regard to the various libraries and the names of the librarians in charge is given in Appendix 7. Additional statistics with regard to the use of the books in these libraries are given in Appendix 2. An account of their bibliographical work and other activities is given in the preceding pages. There have been no important changes during the year in the lines of work carried on by the various libraries and no changes in location.

In their reports the librarians of the Bureau of Crop Estimates and the Bureau of Markets call attention to the large use made of their libraries by workers from several of the new war offices, such as the Food Administration, the War Industries Board, the War Trade Board, and the Council of National Defense. They and the librarian of the Bureau of Chemistry also point out that because of the nature of the work of their respective bureaus much of their library work is of an informational character, comparable to that of a business organization. Other libraries, notably those of the Bureau of Entomology, Bureau of Plant Industry, States Relations Service, and Office of Farm Management, have a larger amount of work of a bibliographical character.

In the case of the Bureau of Biological Survey and the Bureau of Public Roads the major part of the time of those in charge of the libraries is spent in editorial work. The library duties, being somewhat incidental, consume only a comparatively small amount of time. In the Bureau of Markets library, the librarian, as in the case of the Bureau of Biological Survey, is also the official editor of the bureau, but the work of the staff of six is about equally divided between library work and editorial work.

In the Dairy Division the librarian has charge of the correspondence file room and the photographic and slide files, in addition to her library duties. For two months during the year while the position of dairy editor was vacant she took charge of the records of the editorial office and carried on the routine work of the office.

In the States Relations Service library the greater part of the time of two assistants is devoted to the circulation and reference work connected with the Experiment Station Record. All accessions of the main Library are examined daily and articles of interest are called to the attention of the various editors of the Record for abstracting and review. The work of the Library in connection with

the monthly list of extension publications of the State agricultural colleges has been continued.

In her report for the year the librarian of the Bureau of Plant Industry calls especial attention to the periodical circulation. The following is quoted from her report:

For several years one of the most pressing problems facing the Department Library as a whole and the Bureau of Plant Industry in particular has been that of the circulation of current periodicals. The work in connection with this service has grown to such proportions that in the case of the Bureau of Plant Industry it was breaking under its own weight and was failing in its purpose of being "current circulation," since the number of persons receiving the botanical journals most used in the bureau was so large that many of them necessarily received the journals very late, even those of which we had more than one copy. Imperfect as it was, however, any suggestion that the circulation be discontinued was met with universal protest, many asserting that it was the most valuable service rendered by the Library. An analysis of the situation showed that some means of acquainting the workers with the contents of the journals, so that they might request those actually containing articles of interest, would probably serve their needs quite as well as the circulation of the periodicals themselves, so it was finally decided to list the author entries indexed for the botanical catalogue and circulate these lists in mimeograph form every two weeks. The first list was sent out in February, 1919, and the circulation of the periodicals containing articles indexed was discontinued, the journals being held for a week after receipt in the reading room of the Bureau of Plant Industry library. Other periodicals, such as chemical, medical, farm and trade papers, etc., still circulate as formerly. The entries in the mimeographed lists are arranged under the titles of the publications containing the articles, so that those receiving the list may request from the Library any containing articles of interest. These requests are filed in order of their receipt, and, after the reserve period, the publications are sent to each borrower in turn. The reserve period of one week enables any who feel that they must see all periodicals to examine them in the Library. The mimeographed list of articles indexed is sent currently to about 200 persons in Washington or in the field and a few outside the Department who have especially requested it.

The following are the results of this change of plan as observed by the periodical desk after about four months' trial: 122 journals have been removed from circulation. The number of special requests has considerably increased, but there is an appreciable decrease in the work of the periodical assistant, as practically all the work of preparing and distributing the mimeographed list is done by a clerical assistant and messengers. The saving of wear and tear on the journals is considerable. Many periodicals which, when circulated, were kept by the bureau for an indefinite period are now returned to the Department Library very promptly. One copy of a periodical will now serve in most cases where two copies were purchased for circulation in this bureau.

The work of the Bureau of Plant Industry library in connection with the distribution of the bureau publications and the maintenance of the classified mailing lists continues as in former years. Other bureau libraries, namely, those of the Bureau of Entomology, the Dairy Division, and the Office of Farm Management, also are charged with the care of mailing lists.

In summarizing the work of the various branch libraries mention should finally be made of the duties which devolve upon several of them in connection with the purchase of books and periodicals for "field use." The Bureau of Chemistry, Bureau of Plant Industry, Forest Service, and the Bureau of Markets spend very considerable sums each year for books and periodicals needed by the laboratories and field stations maintained by these bureaus outside of Washington. The records in connection with these purchases are kept by the libraries of the bureaus.

APPENDIX 1.

Miscellaneous statistics for the fiscal years 1909 to 1919.

Item.	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Circulation (main Library).....	30,606	35,180	36,250	38,112	36,933	38,879	40,953	48,914	46,339	40,447	36,457
Total circulation (main Library and bureau, division, and office libraries)*.....			65,944	70,655	68,608	74,425	76,647	93,213	86,977	76,329	68,393
Interlibrary loans.....	416	548	613	620	826	896	1,196	1,240	1,093	893	658
Total accessions.....		8,156	8,816	9,122	9,574	9,626	9,243	9,750	8,957	7,823	7,599
Periodicals received currently.....	1,879	2,002	1,978	1,948	2,035	2,128	2,337	2,280	2,219	2,433	2,493
Books sent to the bindery.....	1,910	3,245	3,274	3,930	3,538	3,362	3,832	3,363	4,064	1,674	2,019
Cards added to the catalogue.....	17,611	21,326	19,252	26,777	23,363	20,625	19,735	21,623	19,162	22,383	18,763
Library appropriation.....	\$33,580	\$35,820	\$35,320	\$40,500	\$41,280	\$43,520	\$45,360	\$46,020	\$49,500	\$50,160	\$50,160

* Exclusive of the circulation of current periodicals.

APPENDIX 2.

STATISTICS OF CIRCULATION.

Books and periodicals charged by the main Library and the bureau, division, and office libraries during the fiscal years 1918 and 1919.

Bureau, division, or office.	Number of books charged.								Number of periodicals charged.	
	To individuals.		To main Library.		To branch libraries.		Total.			
	1918	1919	1918	1919	1918	1919	1918	1919	1918	1919
Main Library 1.....	13,332	12,662	-----	-----	27,115	23,795	40,477	36,457	-----	-----
Bureau of Animal Industry:										
Animal Husbandry Division.....	(2)	(2)	(2)	68	-----	-----	-----	-----	4,000	5,720
Dairy Division.....	3,386	1,696	48	82	6	4	2,440	1,782	9,518	10,467
Bicchemic, Pathological, Zoological, and other divisions.....	(2)	-----	-----	-----	-----	-----	-----	-----	10,401	10,500
Bureau of Chemistry.....	8,238	5,700	650	444	24	16	8,912	6,160	15,801	15,501
Bureau of Crop Estimates.....	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	23,032
Bureau of Entomology.....	2,920	3,096	325	176	39	49	3,284	3,321	1,159	3,361
Forest Service.....	2,844	2,685	393	198	2	-----	3,239	2,853	4,987	5,841
Bureau of Markets.....	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	25,000	(2)
Bureau of Plant Industry.....	12,442	12,004	598	492	85	37	13,125	12,532	37,317	37,074
Bureau of Public Roads.....	1,516	528	170	88	12	6	1,698	1,622	6,924	6,693
Office of Farm Management.....	3,118	3,636	58	-----	8	-----	3,184	3,636	10,633	9,108
	46,796	42,007	2,529	1,548	27,292	23,907	76,329	68,393	125,740	195,690

¹ Statistics include circulation in all bureaus and offices for which separate statistics are not given below.² No records kept.³ Circulation statistics included in statistics of main Library.

APPENDIX 3.

Circulation statistics of the main Library, by months and years, for the fiscal years 1909 to 1919.

Month.	1908-9	1909-10	1910-11	1911-12	1912-13	1913-14	1914-15	1915-16	1916-17	1917-18	1918-19
July.....	1,642	2,490	2,357	2,397	2,472	2,651	3,019	3,077	2,932	3,113	2,860
August.....	1,455	2,334	2,381	2,425	2,269	2,083	2,567	3,285	2,883	3,027	2,616
September..	1,893	2,540	2,259	2,517	2,584	2,531	2,793	3,334	2,955	2,968	2,232
October.....	2,714	2,610	3,118	3,404	3,048	3,301	3,903	4,183	4,421	3,617	2,474
November...	2,406	3,567	3,083	3,465	3,152	3,232	3,352	4,439	4,409	3,462	2,684
December...	2,682	3,315	2,952	2,962	3,051	3,226	3,570	4,140	3,797	3,137	2,728
January.....	3,061	3,364	3,535	4,094	4,106	4,454	4,260	4,888	4,839	4,099	3,572
February....	2,798	3,221	3,340	3,851	3,403	3,618	3,638	4,715	4,625	3,603	3,830
March.....	3,000	3,310	3,668	3,614	3,415	4,021	3,980	5,028	4,640	3,676	3,920
April.....	3,169	2,804	3,805	3,415	3,394	3,623	3,514	4,052	3,768	3,444	3,608
May.....	2,913	2,708	2,589	3,208	3,148	2,951	3,072	4,136	3,616	3,531	3,327
June.....	2,873	2,917	3,163	2,760	2,891	3,188	3,285	3,637	3,476	2,770	2,605
Year.....	30,606	35,180	36,250	33,112	36,933	38,879	40,953	48,914	46,339	40,447	36,457

APPENDIX 4.

INTERLIBRARY LOANS.

Record of books lent outside of Washington during the fiscal years 1915 to 1919.

States, etc.	Fiscal year—					States, etc.	Fiscal year—				
	1915	1916	1917	1918	1919		1915	1916	1917	1918	1919
Alabama.....	3		10			New Mexico.....	3	9	8	6	7
Arizona.....	4	14		7	4	New York.....	142	127	148	103	66
Arkansas.....	2	3	4	5	9	North Carolina.....	48	17	15	7	1
California.....	26	50	38	13	28	North Dakota.....	3	11	3	6	6
Colorado.....	27	24	16	7	5	Ohio.....	78	29	41	56	9
Connecticut..	4	2	2	5	1	Oklahoma.....					
Delaware.....	11	10	6	17	11	Oregon.....	51	66	51	73	5
Florida.....	44	21	15	21	17	Pennsylvania.....	21	29	19	21	10
Georgia.....	15	37	24	5	4	Rhode Island.....	6	2	17	4	2
Idaho.....	9	5	10	6	4	South Carolina....	1	22	27	14	2
Illinois.....	7	66	30	44	49	South Dakota.....	3				
Indiana.....	25	20	13	11	4	Tennessee.....	20	31	22	19	11
Iowa.....	63	80	40	52	15	Texas.....	23	11	38	8	9
Kansas.....	59	71	38	31	41	Utah.....	8	17	16	8	8
Kentucky.....	25	7	4	8	13	Vermont.....	21	9	3	3	10
Louisiana.....	2	10	8	21	9	Virginia.....	32	26	18	4	10
Maine.....	8	22	16	10	2	Washington.....	8	11	2	8	21
Maryland.....	25	28	48	30	10	West Virginia.....	12	16	8	19	19
Massachusetts.	36	25	33	22	10	Wisconsin.....	38	41	34	36	62
Michigan.....	22	37	38	21	9	Wyoming.....	4	5	3		6
Minnesota.....	64	78	50	44	63	Canada.....	1		1	1	3
Mississippi..	4		1	1	1	Hawaii.....			3	2	1
Missouri.....	18	15	19	6	2	Porto Rico.....	57	43	39	28	11
Montana.....	5	15	19	37	17	Island of Guam.....					2
Nebraska.....	20	18	10	4		Alaska.....		2			
Nevada.....		3	1								
New Hampshire.	3	2	8	10	7	Total.....	1,196	1,240	1,093	893	653
New Jersey.....	83	53	76	28	42						

APPENDIX 5.

Summarized statement of books borrowed from other libraries during the fiscal years 1915 to 1919.

Item.	1915	1916	1917	1918	1919
Largest number of books borrowed from other libraries on any day..	42	42	41	46	41
Average number of books borrowed from other libraries daily.....	18	23	19	15	16
Largest number of books borrowed from other libraries in any month...	579	734	623	481	613
Average number of books borrowed from other libraries monthly....	460	571	507	396	424
Number of books borrowed during the year from libraries outside of Washington.....	58	86	82	35	70
Number of books borrowed during the year from other libraries in Washington.....	5,463	6,774	6,010	4,717	5,026
Total number of books borrowed from other libraries in and out of Washington.....	5,521	6,860	6,092	4,752	5,096

Of the 5,026 books borrowed from libraries in the city during the year, 4,126 were borrowed from the Library of Congress, 607 from the Surgeon General's library, 110 from the National Museum and Smithsonian Institute, 64 from the Geological Survey, 36 from the Patent Office, 21 from the Public Library, and the remaining 62 from 14 other Government libraries.

APPENDIX 6.

Accessions to the Library for the fiscal years 1915 to 1919.

Accessions.	1915	1916	1917	1918	1919
Purchases:					
Volumes.....	1,353	1,595	1,949	1,510	1,373
Pamphlets.....	39	49	76	79	83
Maps and charts.....		13	1	4	2
Serials and continuations.....	376	274	147	97	154
Total.....	1,768	1,931	2,168	1,690	1,617
Gifts:					
Volumes.....	780	873	641	676	647
Pamphlets.....	500	397	508	642	371
Maps and charts.....	22	18	4	59	15
Continuations.....	4,909	4,919	4,458	3,897	2,647
Total.....	6,211	6,207	5,611	5,181	3,680
From binding periodicals and serials.....	1,085	1,612	1,178	949	718
Total.....	9,064	9,750	8,957	7,823	6,045

APPENDIX 7.

Books, pamphlets, and periodicals in bureau, division, and office libraries.¹

Bureau or office.	Librarian in charge.	Number employed.	Number of books.	Number of pamphlets.	Number of periodicals currently received.	Number of registered borrowers.	Number of registered borrowers to whom periodicals are circulated.
Bureau of Animal Industry: ²							
Animal Husbandry Division.	Miss Jessie Urner.....	1	1,100	4,300	165	28	28
Dairy Division.....	Miss Carrie B. Sherly....	3	918	2,250	275	68	58
Biochemic, Pathological, Zoological, and other divisions.	Miss Elsie Moore ³	1	170	250	287	75	65
Bureau of Biological Survey.	Mr. W. H. Cheesman ⁴ ..	2	6,500	.....	106	37	.....
Bureau of Chemistry.....	Miss Anne E. Draper....	4	7,000	.....	367	266	113
Bureau of Crop Estimates.	Mrs. Ellen H. Painter....	2	16,000	.....	550	55	19
Bureau of Entomology.....	Miss Mabel Colcord.....	2	7,136	9,000	341	207	12
Bureau of Markets.....	Miss Caroline B. Sherman. ⁵	6	3,366	1,350	550	.....	.....
Bureau of Plant Industry.	Miss Eunice R. Oberly..	9	4,000	1,000	739	348	165
Bureau of Public Roads..	Mr. M. A. Hays.....	1	900	4,000	144	.....	.....
Forest Service.....	Miss Helen E. Stockbridge.	1	20,914	.....	82	114	48
Office of Farm Management.	Miss Cora L. Feldkamp.	4	9,050	.....	240	51	46
Office of the Solicitor.....	Mr. F. B. Scott.....	1	1,800	.....	.....	.....	.....
States Relations Service...	Miss E. Lucy Ogden....	8	2,775	4,500	.....	118	69

¹ All books for the use of the Department in Washington, including those filed in the bureaus, are purchased and catalogued by the main Library. No bureau libraries are maintained by the Bureau of Animal Industry and the Bureau of Soils. The Weather Bureau library is administered separately, with the exception that the books and periodicals are purchased from the appropriation for the Library of the Department, the sum of \$1,000 being set aside each year for this purpose. The report of the Weather Bureau library is contained in the report of the Weather Bureau.

² No bureau library is maintained.

³ Periodical assistant.

⁴ Approximate figures.

⁵ Editor and librarian.

⁶ Books and pamphlets.

REPORT OF THE DIRECTOR OF THE STATES RELATIONS SERVICE.

UNITED STATES DEPARTMENT OF AGRICULTURE,
STATES RELATIONS SERVICE,
Washington, D. C., September 25, 1919.

SIR: I have the honor to present herewith the report of the States Relations Service for the fiscal year ended June 30, 1919.

Respectfully,

A. C. TRUE,
Director.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

INTRODUCTION.

The States Relations Service represents the Secretary of Agriculture in his relations with the State agricultural colleges and experiment stations under the acts of Congress granting funds to these institutions for agricultural experiment stations and cooperative extension work in agriculture and home economics, and in carrying out the provisions of the acts of Congress making appropriations to the Department of Agriculture for farmers' cooperative demonstration work, investigations relating to agricultural schools, farmers' institutes, and home economics, and the maintenance of agricultural experiment stations in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands.

The organization of the service includes the following offices: (1) The Office of the Director, which deals with the general business and administration of the service and the work relating to agricultural instruction and farmers' institutes; (2) the Office of Experiment Stations; (3) the Office of Extension Work in the South, including the farmers' cooperative demonstration work and the cooperative extension work in 15 Southern States; (4) the Office of Extension Work in the North and West, including the farmers' cooperative demonstration work and the cooperative extension work in 33 Northern and Western States; and (5) the Office of Home Economics, including investigations relative to foods, clothing, and household equipment and management.

During the past year the service continued to have charge of the work authorized by Congress in the item in the food-production act of August 10, 1917, providing "for increasing food production and eliminating waste and promoting conservation of food by educational and demonstrational methods through county, district, and urban agents and others." A war emergency fund of \$6,100,000 for this purpose was used through the two extension offices for the expansion of the work of the county agricultural agents, home demonstration agents, and boys' and girls' clubs.

The service directly administered regular and emergency appropriations aggregating \$7,304,940, and had administrative and advisory relations in the expenditure of \$4,020,000 of Federal funds (\$1,440,000 for agricultural experiment stations and \$2,580,000 for cooperative extension work) and \$2,100,000 of State funds used as an offset for Federal funds under the cooperative extension act. In addition, the agricultural colleges and experiment stations used in experimental and extension enterprises over \$8,750,000 derived from sources within the States.

In the fiscal year 1918-19 the force carried on the rolls of the States Relations Service aggregated about 7,000 employees. The total number of persons employed in cooperative extension work in agriculture and home economics was about 7,500. Over 2,400 counties had agricultural agents and about 1,700 counties and 200 cities also had home demonstration agents. About 2,000,000 boys and girls were connected with the agricultural and home economics clubs. In the fiscal year 1917-18 the State agricultural experiment stations employed 1,684 persons, of whom 449 did some extension work.

Up to the signing of the armistice the service was busily engaged in aiding the State and county extension forces and through them the farmers throughout the country in increasing agricultural production to meet the war needs, and both country and city people in conserving the products and making most economical and effective use of available supplies. During the remainder of the year special attention was given to the problems of agriculture and household economy growing out of the discontinuance of military operations and the beginning of adjustment to meet conditions arising in the settlement of world affairs after the war. An effort was also made by the extension forces to perfect and establish on a permanent basis the cooperating agencies among the farming people, in order that the extension work might rest more securely on the initiative and active participation of the people themselves.

Uncertainty regarding the policy which would finally be adopted in making grants of Federal funds in lieu of the war-emergency appropriations made it impracticable to determine definitely the amounts of State and local funds which would be required to maintain the existing organization and work in the several States and localities. For this and other reasons the fiscal year closed without settlement of important problems regarding the continuance of various agencies and methods for extension work on the scale on which they had been organized in war time. It is now evident, however, that the system of extension work extended so rapidly under war conditions has commended itself to the people in very large measure as a thing which will be useful to them in times of peace. They are therefore making strong efforts to maintain it by local contributions, as far as these are needed to supplement Federal and State funds. The number of counties in which it has been necessary to withdraw the agricultural agents is much smaller than was anticipated. Several hundred home demonstration agents have been discontinued. But there is a general feeling that in a comparatively short time the extension forces will be as numerous as ever and that the system will continue to grow until it covers the entire country.

The close of the war has brought the agricultural experiment stations in the States back more completely to their fundamental work of agricultural research. The changes in their activities and personnel during the war have necessitated considerable reorganization of their forces and projects. In this readjustment work the Office of Experiment Stations is giving them as much assistance as possible. The experiment stations maintained by the service in Alaska and the insular territories are continuing both research and extension work, taking advantage of the increased interest in the agricultural development, due to the imperative demand which the war brought about, to make those regions more self-supporting.

The Office of Home Economics, through participation in the food survey conducted by the Bureau of Markets and in the work of various war-time agencies dealing with problems of the conservation and utilization of agricultural products, has gained and disseminated much valuable information which will serve as a basis for research needed in connection with teaching and extension work in home economics.

The movement of events growing out of the war has greatly stimulated the interest of our people in vocational education. One result of this has been that the department has been called upon in increased measure to furnish the up-to-date information and illustrative material in agriculture and home economics which the schools need to make their work in these lines most effective. The States Relations Service has done what it could to aid the schools in developing satisfactory courses of instruction in these important branches.

OFFICE OF THE DIRECTOR.

The general administrative business of the States Relations Service continued to be very large and complicated, owing to the large emergency appropriation and the great variety of cooperative arrangements with Federal, State, and local organizations. The temporary employment of several thousand emergency field agents, with provision for their travel, supplies, publications, etc., necessitated a vast amount of routine business, much of which could not be properly standardized because of the shifting character of the force. The loyalty and self-sacrificing spirit of the force, as a whole, was very commendable, but especial credit should be given to the experienced administrative officers and their assistants, who carried the chief burden of responsibility under very difficult conditions.

EDITORIAL DIVISION.

W. H. BEAL, *Chief.*

The work of this division included the business connected with (1) the editing of all publications of the service except Experiment Station Record, and (2) the collection, preparation, and distribution of illustrative material.

There was a decrease in the number of different publications issued during the year, but many of them, especially those bearing on food production and conservation, were printed in large editions to meet emergency demands, so that the number of copies was greater than

in previous years. The publications issued included 64 documents aggregating 3,997 pages, as follows: Nineteen numbers of Experiment Station Record, 2 reports, 6 technical bulletins (2 relating to work in agricultural education and 4 to investigations in home economics), 1 article in the Journal of Agricultural Research, 10 publications of the insular stations, 2 popular lectures (with lantern slides), 20 documents relating to cooperative extension work in agriculture and home economics, and 1 general administrative circular. In addition to these more formal printed documents the service issued either in printed or in mimeographed form a number of other documents, including leaflets of various kinds, report forms, record books, and the like, required in connection with special features of the work of the service, and cooperated with the Office of Information in the preparation of press and other informational material of wider general interest relating especially to the promotion of increased production, conservation, and economical use of food and the organization and development of the cooperative extension work.

ILLUSTRATIONS SECTION.—This section was in charge of Reuben Brigham. There was a marked increase in the work of the section connected with the collection and preparation of illustrative material for service use. An increased number of photographs taken either by our own force or in cooperation with the Division of Publications was added to the collection, which now contains about 10,495 photographs, 7,826 of which are mounted, classified, and catalogued for ready use. Over 1,500 new photographs were added to the collection during the year.

The total number of lantern slides made was 15,253, of which 3,153 were colored. The section organized several new series of lantern slides for special purposes, particularly for the use of extension specialists, county agents, or other workers cooperating or collaborating with the service. It is developing in this way a flexible collection of slides that may be adjusted to met a large variety of local needs and conditions. The division continues to make a special feature of lantern-slide color work with the result that it now has a considerable collection of colored slides of unusually high quality. In addition to the coloring of lantern slides some attention is being given to the coloring of bromide enlargements.

The methods of handling the illustrative material, particularly lantern slides, were also improved. There were lent during the year, mainly to extension workers and schools teaching agriculture, 1,346 sets aggregating 67,300 slides. The demand for this service has increased rapidly.

Work in the preparation of charts and drawings for service use progressed rapidly during the year as a result of the employment of a competent artist to give full time to such work.

The section cooperated with other offices of the service and with the Office of Exhibits of the department in planning and preparing a representative exhibit of the work of the service for use in connection with the general department exhibit for State fair circuits. The section also cooperated with other offices of the service and with the assistant in charge of motion-picture activities in outlining and staging two films illustrating cooperative extension work, one in Florida, illustrating home-demonstration work in the South, and

the other in Maryland, illustrating cooperative extension work and organization in relation to improving methods of apple production.

Several mimeographed circulars explaining how to make good photographs, lantern slides, and charts for extension and school use were issued.

INVESTIGATIONS ON AGRICULTURAL INSTRUCTION IN SCHOOLS.

ALVIN DILLE, *In charge.*

Particular attention was given during the year to the preparation of subject matter in form for use in teaching vocational agriculture in secondary schools, and to plans for training teachers for these schools. At the same time the elementary rural school studies were not neglected.

Previous to the signing of the armistice there was cooperation with other divisions and bureaus in promoting instruction relating to problems of food production and conservation. Studies were made of the training of unskilled farm labor and of city boys to do farm work. Studies of the educational work of the colleges with the Students' Army Training Corps, especially the instruction in agriculture being given to these men, were also begun. Sets of lantern slides, charts, and reference material were supplied to instructors in agriculture at various army camps. The signing of the armistice brought a sudden end to this special war work, and after that time attention was turned to problems of readjustment in agricultural teaching.

The preparation of material in the form of bulletins, circulars, leaflets, etc., for the use of teachers of agriculture continued to receive a large amount of attention. Lessons in dairying and on potatoes for rural elementary schools were published in bulletins which were widely distributed. Twelve leaflets on how teachers may use certain Farmers' Bulletins were also printed and distributed. Owing to an increased demand for material for use in schools teaching agriculture a number of earlier bulletins were reprinted.

The preparation of a two years' course of study for negro vocational schools was undertaken in cooperation with the Federal Board for Vocational Education. The first year's course, lessons in crop production, was completed and turned over to the Federal Board, and the preparation of the second-year course, lessons in animal production, was well advanced. A conference was conducted at Hampton Institute with negro teacher trainers and supervisors of agriculture, at which the first course was carefully reviewed and explained.

While the war checked in some measure the development of instruction in agriculture, the interest in agriculture was greatly increased by the emphasis placed on food production and conservation. With the close of the war State authorities began to turn their attention to the development of the agricultural schools, more especially those teaching vocational agriculture. This was shown by the increased demand for material that would help in the solutions of their teaching problems.

The demand for help in visual instruction was in excess of the supply of material available. During the year there were prepared the following lantern-slide sets with mimeographed syllabi: Lessons in planning and planting a garden; lessons on dairying; a six weeks'

course in farming for women; war camp farms in the United States in 1918; a revision of the home projects in agriculture. There were also available for use in this work sets of slides, with lecture notes, on the farm water supply; flies and their relation to health; the mosquito and its relation to health.

The lantern-slide service has had a wide range, including schools in 32 States and a few schools in Canada. Slides were also loaned to the Y. M. C. A. camp service for use both in the United States and in France. In Texas and Massachusetts a set of each of the slides was placed in charge of the State departments of agricultural education to be sent out on circuits to the schools teaching agriculture. This service proved very effective and it is hoped will be extended during the coming year. Plans were developed to widen the scope and type of illustrative material, especially to assist the States to obtain duplicates of the material available.

The division continues, as heretofore, to review and abstract for Experiment Station Record the literature on agricultural education, this work requiring a large portion of the time of one member of the staff.

During the year various field trips were made by members of the staff, including visits to State and regional conferences of agricultural directors, supervisors, and teachers; associations at which agricultural instruction was discussed; State colleges giving attention to the training of teachers of agriculture; and schools giving instruction in agriculture. During these trips conferences were held and all assistance possible given to the men in the field.

Relations of the most cordial nature were maintained with the various bureaus of the department and helpful assistance was rendered by these bureaus.

INVESTIGATIONS ON FARMERS' INSTITUTES.

J. M. STEDMAN, *Farmers' Institute Specialist.*

Farmers' institute work in the United States during 1918 as compiled from reports from 31 States included 6,941 institutes, which lasted 7,184 days, comprised 14,446 sessions with an attendance of 1,916,706, employed 2,002 lecturers, and cost \$260,826.09, divided between State appropriations of \$184,463.24 and other funds contributed to the amount of \$76,362.85.

The States Relations Service continued to aid farmers' institute workers, as well as county agents and other extension teachers throughout the country, along the same lines as heretofore. Three new lectures, *Renovating the neglected apple orchard*, *Growing and handling Irish potatoes*, and *The city and suburban vegetable garden*, were published, each accompanied with 50 lantern slides. These lectures were used not only by farmers' institute lecturers but more especially by county agricultural agents, from whom the demand is constantly increasing. They are also used by home-demonstration agents, club leaders, teachers of agriculture in high schools, and extension teachers in agricultural colleges, by grange lecturers, and by other persons who desire aid in presenting their subject before audiences of farmers.

During the year lectures, each accompanied with a set of 50 lantern slides, were loaned to 604 extension workers.

OFFICE OF EXPERIMENT STATIONS.

E. W. ALLEN, *Chief*.

The Office of Experiment Stations continued to exercise its three-fold function of administration, advice, and publication, with reference to the experiment stations in the States sharing in the Federal appropriations for experimentation and research in agriculture. In discharging this function it not only exercised supervision of the work and expenditures of the stations in order that the intent of the Federal laws might be realized, but it aimed to stimulate and assist the activity intended to be promoted by these laws. This was done as heretofore by maintaining close contact with the stations through annual visits to the stations, correspondence, and the editorial pages of Experiment Station Record.

The publication activity of the office was represented by an annual report to Congress on the work and expenditures of the State and insular stations, the issue of Experiment Station Record, and the preparation of the card index of American experiment-station literature, which has been in progress for nearly 30 years.

RELATIONS WITH THE STATE AGRICULTURAL EXPERIMENT STATIONS.

The needs arising under war conditions brought the work of the State experiment stations and of this department and other Federal and State agencies into closer and more intimate relationship, giving rise to numerous cooperative endeavors. The stations were called upon for unusual forms of service, which often required interpretation of the Federal acts in relation to such use of the funds. Under the circumstances as liberal an attitude was followed as was felt to be warranted, and in general it was maintained that as far as the Federal funds were concerned the stations should continue to retain their character of institutions for investigation and its interpretation in practice.

The disturbing influences of war conditions had a noticeable effect upon the stations and their work. Aside from the unusual demands upon them for various forms of service, they experienced considerable difficulty in maintaining their staffs, heavily drawn upon for the Army and for other work incident to the war. The reduction in the total of station officers and assistants, even taking into account the replacements, amounted to more than 15 per cent during the period of the war. This unavoidably had an unfavorable effect on the station work, leading in some cases to the abandonment for the time being or modification of lines of study for which suitable workers could not be secured.

New administrative officers entered upon their work during the year at several of the colleges and stations, and in a number of instances the stations were in charge of acting directors during the absence of the station head on war-emergency or reconstruction duties. Such changes, together with changes in the station personnel, called for special attention to the details of administrative management and policy, the proper safeguarding of the organization and the employment of funds, assistance in filling vacancies, and the like.

The register of persons available for agricultural investigation maintained by the office was of special value to the stations in se-

curing men for their various lines of work, and also to returning soldiers trained in scientific agriculture in locating and obtaining positions.

The office, like the stations, returning during the year to a readjustment basis, found many new matters needing attention, among them the maintenance of the experiment stations in the proper relative position with respect to other branches of the agricultural work. The key position occupied by the stations as originators and interpreters of the information employed in teaching and extension work emphasizes the prime importance of maintaining them on a basis of progressive strength commensurate with the growth of these other branches.

EXPERIMENT STATION RECORD.

In accordance with the general plan in operation for several years, volumes 39 and 40 of the Experiment Station Record, each consisting of nine numbers and the usual author and subject indexes, were prepared during the year. These volumes contain 7,023 abstracts of the world's scientific literature pertaining to agriculture, together with monthly editorials discussing important phases of the developments in agricultural investigation and brief notes on the progress of institutions for agricultural education and research in this country and abroad.

The total number of articles abstracted was practically identical with that for the previous year. Special attention was again given to the selection of material of immediate usefulness under the war and postwar conditions. Likewise many of the editorial articles took up some phase of the effects of the war on research in agriculture and the opportunities and problems confronting research institutions.

INSULAR STATIONS.

The Office of Experiment Stations, as heretofore, had direct charge of the Federal experiment stations in Alaska, Hawaii, Porto Rico, and Guam, administering their work and expenditures through the local agents in charge.

At the beginning of the fiscal year, and for several months thereafter, these stations were busily engaged in problems connected with increasing production and conservation of food. The policy of agricultural diversification, which has been continued since the establishment of the stations, was fully justified by the results obtained. The stations suffered by reason of the departure of many of their men for military service. The manner in which the remaining members of the staffs took up the additional work is worthy of commendation.

The agricultural experiment station on the Island of St. Croix was taken over on January 1, 1919, becoming the experiment station of the Virgin Islands. This station, with an area of about 200 acres, is to be developed as rapidly as possible to cover all lines of agricultural investigation, and the work is to be extended to the other islands of the group.

The administrative heads of the stations remained without change.

The appropriations for the stations for 1919 were: Alaska, \$65,000; Hawaii, \$45,000; Porto Rico, \$45,000; Guam, \$20,000; and Virgin Islands, \$15,000. These sums constitute the resources of the stations, the current sales funds no longer being available for use.

The stations continued to enjoy the cooperation of the various bureaus and divisions of the department, and their work was greatly assisted in this way. Hearty acknowledgment is made for the aid thus received.

The administrative and financial review of the affairs of the stations in connection with the States Relations Service continued, as formerly, under the supervision of Walter H. Evans and the accounting office of the service.

ALASKA STATIONS.

The Alaska stations continued in direct charge of C. C. Georgeson. Stations were maintained at Sitka, Kodiak, Rampart, Fairbanks, and Matanuska. The headquarters is at Sitka.

At Rampart, practically every variety of spring grain sown in 1918 ripened. Of 76 varieties of spring grain that matured, more than half were hybrids that had been produced at the station. Many of these seem to have become fixed in character and they are being propagated for wide distribution throughout the Territory.

At Fairbanks the yields were less than in some years, but barley yielded 30 bushels per acre and oats 48 to 50 bushels per acre when sown on a field scale. An especial effort is being made to increase the stock of some spring wheats for distribution for seed purposes. These grains were received from the experiment station at Tulun, Siberia, and have proved well adapted to Alaskan conditions. About 65 bushels were distributed in 1918 to be grown for seed purposes, and it was estimated that more than 500 acres of wheat would be sown in the Tanana Valley in the spring of 1919. The station at Fairbanks made milling tests of the various grains, and samples of whole wheat flour produced by the station were given a baking test by the Bureau of Chemistry of this department, which showed the flour to be of high grade. The report on the test states: "This flour makes a very good loaf of bread; in fact, it is one of the best whole wheat or graham flour breads we have had occasion to make."

At the Matanuska station, most of the work is still of a pioneer nature, but quite a little was done with various crops during the year. Cereals sown for grain hay matured, and there was a large production of potatoes of good quality. An attempt was made to grow sugar beets in a small way and analyses of roots sent to this department showed an average sugar content of 15.9 per cent. Experiments to determine the possibility of growing sugar beets for seed were undertaken.

At the Kodiak station, the work with sheep and cattle progressed favorably. The herd of cattle was tested for tuberculosis for the fourth time and no new reactors were found. Of the calves dropped by reacting mothers but reared on pasteurized milk, only one out of eleven showed any suspicious symptoms when tested for tuberculosis.

In an effort to eradicate tuberculosis in cattle, cooperative work was carried on with the Territory in testing cattle in all the more accessible localities, the legislature having made an appropriation for that purpose.

The extension work begun as a war emergency project was continued and considerably expanded. Large quantities of seed and

plants were distributed and advice was given regarding the crops that could be expected to succeed and the best methods to be pursued in growing them.

A number of farmers' meetings were held in the Matanuska and Tanana valleys during the year, and were well attended. A recent report shows there have been taken up, under the various homestead laws, 518 claims embracing approximately 103,840 acres.

The plant breeding and horticultural work at Sitka station progressed favorably and large numbers of hybrid strawberries, and other fruits and plants adapted to Alaskan conditions, were distributed.

HAWAII STATION.

This station continued in charge of J. M. Westgate. While the more formal projects were by no means abandoned, and the importance of diversified agriculture continued to be emphasized, the energies of the station were largely devoted during the year to some of the more pressing problems relating to the production and conservation of food for man and forage for animals.

The chemical division paid especial attention to the conservation of Hawaiian fruits and vegetables. A fruit and vegetable drier was constructed that produced a much better product than that obtained by the usual methods and the practicability of drying bananas and various vegetables was demonstrated. The work with starches attracted much attention, and the commercial manufacture of starch from cassava, edible cannas, taro, and other plants, has been undertaken on several of the islands. The starch of the edible canna was found to be easily digested. A satisfactory method was worked out for the manufacture of vinegar containing 4 per cent or more of acetic acid from waste pineapple juice.

The horticultural work was confined largely to studies of the best varieties of tropical fruits for Hawaiian conditions. A survey was made of the coffee industry as to its condition, its necessities, and also the location of possible sources of caffeine in the pulp prunings, etc., that are now wasted.

The agronomy division has demonstrated the superiority of Guam corn over any other variety grown at low elevation in Hawaii. There is local prejudice against white corn and efforts are being made to cross this variety with some good yellow sort. Important results have been secured in sweet potato breeding work and some promising hybrids are under observation.

The plant pathologist has discovered the cause of a very destructive banana disease and has worked out a seemingly satisfactory method of control. This method, which includes sanitation and spraying, was applied to a 75-acre field with promising results. A comprehensive study of root rots of bananas, pineapples, and sugar cane was begun.

The extension division, through its superintendent on Maui, kept in close touch with the agricultural interests of the islands. Demonstrations were made of the curing of pork, caponizing, increased production of corn, pigeon peas, cassava, etc., and of the practicability of producing concentrated feeds to replace grain brought from Califor-

nia. Corn, calf, and pig clubs were established and a beginning made looking toward organizing farm bureaus for the leading agricultural sections of the islands. The work of the various collaborators was continued and many localities are being reached in this way. During the year an extension agent was appointed for the island of Hawaii.

The cooperative work with the Territorial Food Commission was highly successful and the relations were very satisfactory. The work carried on in cooperation with the War Department at Schofield Barracks was continued and considerably extended, and plans were matured for extensive plantings of forage and other crops suited to the locality. The cooperation maintained between the station and the Territory at the Glenwood station on Hawaii was terminated by failure of the legislature to continue the appropriation which had been made for about six years. Provision was made for continuing the work for a time on a collaborator basis.

The Territorial marketing division, established by the station in 1913 and wholly taken over by the Territory in 1917, was intended to provide a means for the disposal of small quantities of produce and thus foster diversified agriculture. The amount of business of the market increased so rapidly that it was selling about \$20,000 worth of island produce a month. Later the retail privilege was withdrawn, and the legislature at its last session did not continue the appropriation for its maintenance.

PORTO RICO STATION.

D. W. May continued as local agent in charge of this station. The work of the station during the year was directed mainly along two lines, investigation and extension. The investigational work was in continuation of projects that have been in progress for some years. The extension work was carried on through demonstrations, meetings, and the distribution of seeds and plants, literature, etc. One of the important lines of investigation was in connection with the mottled leaf disease of sugar cane. This disease has spread rather widely and threatens to curtail sugar production. The station cooperated with the department in making a study of insects as carriers of the disease, the cause of which is as yet unknown. The question of varietal resistance has been given especial attention. Several years ago the station introduced a considerable number of varieties of sugar cane from other tropical countries and among them are several which show more or less resistance to the disease. Efforts are being made to increase seed cane of one of these varieties as rapidly as possible for planting in the infected portions of the island. As a result of the station's investigations on vanilla a number of commercial plantings, ranging from 1 to 10 acres in extent, have been made. Studies were continued on some of the problems relating to the preparation and marketing of the crop.

The rice work, begun a year ago in cooperation with the Office of Cereal Investigations, has yielded promising results. Nursery and other plants have been planted at the station and about 130 acres were sown in field trials carried on by the station and growers in various

parts of the island. The results obtained in 1918 were considered so satisfactory that larger plantings were made in 1919.

In furtherance of work in crop rotations and the use of leguminous plants for food, forage, and green manure, soy beans, and other legumes have been introduced and are meeting with much favor.

The station continued to give attention to the development of the fruit industry, especially citrus fruits, pineapples, mangoes, and avocados. Methods have been worked out in cooperation with the Bureau of Chemistry for the manufacture of fruit juices, thus making a market for otherwise unmarketable fruits.

Experiments in corn improvement were resumed, attention being paid to local varieties that are already acclimated, and the possibility of increasing the yields through care in seed selection has been shown. Similar work with other crops was begun.

In the extension work 1,741 meetings were held during the year and 500 field demonstrations were conducted. Statistical data were collected which show that in 1918 there were planted 413,158 acres to the 10 most important food crops of the island—corn, with 103,577 acres, and beans, with about the same acreage, leading. The main crops, such as sugar cane, tobacco, coffee, and fruits, are not included.

Previous investigations of the station having shown the practicability of cattle tick eradication, the station having been kept free of ticks for some time, an active campaign was begun to eradicate the tick. Ten dipping vats were constructed and about 80 more projected. The outlook for the success of such a campaign seems promising.

GUAM STATION.

The local agent in charge of the Guam station was C. W. Edwards. The island of Guam was visited on July 6, 1918, by a very destructive typhoon accompanied with heavy rain. Much damage was done to the station buildings, fences, and grounds. A number of the station pigs, goats, and chickens were killed, and practically all crops were destroyed. This necessitated beginning anew with many of the projects in agronomy and horticulture. Seeds and plants had to be secured and much of the material was not received until after the most favorable season for planting. A severe drought, extending from February to June, followed, and the effects of the two unusual conditions were reflected in the station work.

In the animal husbandry work some changes were necessary, due to the typhoon. This was especially true in feeding experiments because of the destruction of nearly all native feeds under test. Shortage of feed made it impossible to continue other lines of investigation. An experiment, in which comparison was made between the native practice of tying pigs under shade trees and confining them in properly constructed pens, showed a decided advantage in favor of penning, and many farmers are now providing suitable inclosures for their swine. In the poultry department most of the young breeding stock was lost in the storm of July 6. Work was continued with a Rhode Island Red-native cross. This cross has met with great favor, is hardy, and of good size, and efforts are being made to establish the strain and produce it in quantity for use by the people in grading up their flocks. The breeding work with cattle and goats was continued as in previous years.

The work with corn has been especially valuable. Much of the station crop was saved after the storm. This and all native supplies which were commandeered after the typhoon were used as seed supplies and most of the corn later planted was station-produced seed. The problem of drying and storing the available seed supplies was successfully worked out with the result that the island government is offering at cost insect and moisture-proof tanks modeled upon those at the station. The two grasses, *Paspalum dilatatum* and Para, were the only forage to survive the typhoon and later drought, and they supplied about the only source of forage. Plantings of cowpeas made immediately after the storm gave very satisfactory results in supplementing and extending the limited grass pasture.

More than 200 pot tests were begun at the station to determine the crop adaptations and fertilizer requirements of certain peculiar Guam soils. The station distributed more seed and plants to farmers during the year than ever before, the distribution including garden seeds, 6,575 packets; plants, 3,028; seed corn, 7,025 pounds; and large quantities of cowpeas and velvet beans.

In March, extension work was definitely begun by W. J. Green, formerly connected with such work in Oklahoma. Three lines of work were inaugurated, farm demonstration for adults, boys' and girls' club work, and school gardens. The island was divided into 15 patrol districts, and the patrolmen, who were chosen from marines having knowledge of farming, cooperated with the extension department. The insular authorities showed a deep interest in this work and aided it in every way. The demonstration work included crops, live stock, and beekeeping. Within three months after the work was started clubs with 499 enrollments had been organized. The school-garden work had been organized for a longer time and at the end of the year 377 boys were engaged in this work. A garden has been established in connection with every school in the island. The extension agent directs the planting and care of the gardens and the superintendent of schools has charge of the disposal of the produce.

VIRGIN ISLANDS STATION.

In the act making appropriations for this department for the fiscal year ending June 30, 1919, provision was made for an experiment station in the recently acquired Virgin Islands. Arrangements were made through the naval governor to take over the experiment station formerly established by the Danish Government on the island of St. Croix, and on January 1, 1919, the station passed under the jurisdiction of this department and became the Agricultural Experiment Station of the Virgin Islands. The former director, Longfield Smith, was continued in charge, and an entomologist was added to the staff. Considerable repair and reconstruction work was done and equipment was secured.

The work of the station at present consists almost entirely of crop investigations, which are continued along the lines which have been established during the past seven years, including especially experiments of various kinds with sugar cane; cotton breeding; corn selection, crossing, and culture; tests of leguminous crops for forage and for green manure (including velvet beans, Lyon beans, cowpeas, Mad-

agascar beans, alfalfa, and others); and replacement of sugar cane by coconut plantations. Experiments are also in progress with citrus and other tropical fruits, sweet potatoes, etc.

The work thus far has been confined to the island of St. Croix, since it embraces most of the readily tillable land. The islands of St. Thomas and St. John are believed to offer opportunities for stock raising, pineapple growing, sisal production, etc., which should be developed as rapidly as possible. St. Thomas is considered to offer favorable opportunities for various horticultural industries which should be investigated and developed.

OFFICE OF EXTENSION WORK IN THE SOUTH.

BRADFORD KNAPP, *Chief.*

The Office of Extension Work in the South has charge of the co-operative extension work of the Department of Agriculture in the 15 Southern States. Its functions, administrative organization, and relationships with the subject-matter bureaus of the department and with the State extension services were not materially changed during the year.

ADMINISTRATIVE FORCE.

During the fiscal year ended June 30, 1919, there were in the Southern States 15 directors of extension; 15 State agents or assistant directors; 79 assistant State and district agents; 1,031 county agents; 93 assistant county agents; 177 negro agents and 105 boys' club agents; 15 State home demonstration agents; 82 assistant State home demonstration agents and district agents; 763 county home demonstration agents; 250 negro women agents; 50 white women city agents, and 7 negro women city agents.

Within the Department of Agriculture the Office of Extension Work in the South was represented by 1 chief, 1 assistant chief, 5 field agents in the administration of the county agent and co-operative extension work in the States; 4 men and 4 women in the administration of the home demonstration work and the boys' and girls' club work, and the necessary office assistants and clerical force. There were also during the year 10 representatives of subject-matter divisions of the department cooperating with the Office of Extension Work in the South in taking technical information from the Department of Agriculture to the States.

FINANCES.

The total amount available for extension work in the Southern States in 1918-19 was \$6,277,576, exclusive of the amount spent for the support of the office at Washington. Of this amount, \$2,205,500 was from the emergency fund and \$4,072,076 was from regular appropriations to the department, the Federal and State Smith-Lever funds, college funds, and the large appropriations made by various counties.

Taking the figures, without the emergency fund, and averaging the 15 Southern States, we find that 8.1 per cent was spent in administration; 2.1 per cent in printing and distribution of publications; 43 per cent for county agents; 24.7 per cent for home demonstration agents, and 4 per cent for boys' club work, while 18.1 per cent was spent for specialists.

The average percentage of all funds, exclusive of the emergency fund, spent for the three principal projects—county agricultural agents, county home demonstration agents, and boys' club work—was 71.7 per cent. If we add the emergency fund to these figures and take the grand total, the percentages expended for the different lines of work are, county agents, 49; home demonstration agents, 28.8; boys' club work, 3.8; specialists, 11.7; publications, 1.4; and administration, 5.3. The percentage given for specialists does not include the amounts expended for specialists from various bureaus of the Department of Agriculture.

The proportionate amounts expended for county agricultural agents and for county home demonstration agents vary in the different States. In some States less than half as much is expended for home demonstration work as for county agent work, while in one State the sums expended for these two purposes are practically equal.

The following table shows the expenditures for the various lines of work classified under general subjects:

Amounts and percentages of funds allotted to various lines of extension work in 1918-19 in the Southern States.

Line of work.	All funds except emergency.		Emergency fund.		Total.	
		Per cent.		Per cent.		Per cent.
Administration.....	\$331,346	8.1			\$331,346	5.3
Publications.....	86,988	2.1			86,988	1.4
County agents.....	1,750,984	43.0	\$1,328,815	60.3	3,079,799	49.0
Home demonstration agents...	1,007,450	24.7	801,385	36.3	1,808,835	28.8
Boys' clubs.....	161,543	4.0	75,300	3.4	236,843	3.8
Specialists.....	733,765	18.1			733,765	11.7
	4,072,076	100.0	2,205,500	100.0	6,277,576	100.0

COUNTY AGENTS.

ORGANIZATION.

Each county has an organization cooperating with the county agent and the State extension service in the work of improving agricultural conditions. In the majority of the Southern States these organizations consist of community organizations of farmers and their families, the county organization generally consisting of representatives from such community organization. In the most of the Southern States this county organization is known as the county farm council; in some it is known as the county farm bureau. Two-thirds of all the counties in the South have perfected such organizations within the last few years, while the other third all have the foundation laid in community organizations but have not reached the perfection of organization outlined above. These organizations,

with the help of the county agents, both men and women, outline the community and county plans of work and participate actively in the carrying out of the programs undertaken. The main feature of the work undertaken through these organizations is the demonstration conducted by the farmer himself (see p. 369).

Besides these demonstrations, meetings are held from time to time and miscellaneous information is given for the purpose of helping individuals to solve difficult problems.

FINANCES.

The money available for the support of the county agent work during the past year was larger than in any year previous. The total amount of funds devoted to the county agent work in the 15 Southern States in 1918-19 was about \$3,080,000, from the following sources:

Smith-Lever fund, Federal and State-----	\$660,000
Emergency fund-----	1,329,000
U. S. Department of Agriculture, direct appropriation--	375,000
County and other local funds-----	716,000

The average salary paid to the county agent in the Southern States is about \$2,000. Generally he receives a part or all of his traveling expenses in addition to this.

PLAN OF WORK.

In the South the county agent is recognized as the leader in all of the agricultural extension activities in his county. Through him the efforts of all members of the extension service—State and district agents, specialists from the State agricultural college and the United States Department of Agriculture, and club agents—reach the farmer. The activities of the county agent fall into two main lines, work with men and boys' club work. In the South the boys' club work is one of the main activities of each county agent.

In most instances a written plan of work for the year is prepared by the county agent in cooperation with the district agent, specialists, and the advisory committee of the supporting county organization, and subject to the approval of the cooperative extension authorities. This includes a program of demonstrations, both personal and community, with crops and live stock, special campaigns, field meetings, organization work, marketing, organization of boys' clubs, etc.

RESULTS.

The general effect on southern agriculture of a continuous and consistent program of better balanced farming is now evident. The acreage in corn shows a very great increase during the past 10 years in Alabama, Georgia, Mississippi, and South Carolina. The total corn acreage in the Southern States has increased 17.9 per cent since the year 1909 (census), wheat 150 per cent, oats 98.7 per cent, hay 113 per cent, Irish potatoes 64.5 per cent, sweet potatoes 64.6 per cent, rice 32.3 per cent, peanuts about 100 per cent; grain sorghums have increased, from 1915 to 1919, 26.7 per cent in Texas and Okla-

homa alone, and velvet beans increased from a small acreage in 1910 to 4,318,000 acres in 1918. The acreage of cotton in 1918, though large, was exceeded three times during the past 10 years.

The live-stock industry in the South has had a similar experience. The growing of more hay, forage crops, and grain, especially corn, soy beans, peanuts, oats, and velvet beans, has greatly increased the production of both hogs and cattle. Dairy cows have increased in the Southern States 10 per cent since 1910. Owing to the protracted drought in western Texas and Oklahoma, the actual number of "other cattle" in the South shows a slight decrease. One-third of all cattle in Texas had to be marketed during 1917 and 1918 to keep them from starving, owing to the most disastrous drought in the history of the western territory. In the sections east of Texas a very large increase is shown.

The campaign for more hogs, with the effective demonstrations put on by the pig-club boys, has greatly advanced the hog industry in the Southern States. Cooperative carload shipments, fostered by the county agents, had a very distinct effect in stimulating this industry. Since 1910 the total number of hogs in the Southern States has increased 31 per cent. Of the 20 highest States in the point of hog production in the United States, 10 are Southern States.

DEMONSTRATIONS.

The corner stone of the county agent work in the South is the actual demonstration conducted by the farmer on his own land with the help of the county agent and specialist. More often than not the demonstration is on a community basis, that is, the farmer conducting the demonstration does so for the purpose of illustrating better practices to himself and to his neighbors. The effect of the demonstration is often very materially increased by the fact that neighbors are copying the practices on their own farms. The total number of acres in crop demonstrations in 1918 was 3,207,848. The total number of farmers demonstrating was 317,509.

The largest acreage in demonstrations with one crop was in corn. More than 70,000 demonstrators cultivated a total of 774,449 acres under special instruction, with an average yield of 35 bushels an acre, more than doubling the average of the whole territory.

There was a great increase in the number of wheat demonstrations. In 1917 there were 19,741, while in 1918 there were 50,310 such demonstrations on a total acreage of 317,948, the average yield being 19.7 bushels per acre.

There was also an increase in rye and peanut demonstrations.

ORCHARDS.—There were nearly four times as many demonstrations in orchards in 1918 as in the year before, there being 19,789 demonstrations with a total number of 705,690 trees. County agents gave advice and counsel regarding pruning, spraying, and otherwise treating 45,716 orchards, involving a total of nearly 5,000,000 trees.

LIVE STOCK.—In 1918 the county agents assisted farmers in bringing in 4,395 head of horses and mules and, with the assistance of

specialists, conducted 859 feeding tests, involving 3,821 animals. They helped bring in 12,647 head of pure-bred dairy cattle and 14,997 grades. They helped the specialists in dairying to conduct 1,052 feeding demonstrations, involving 19,200 animals. Outside of the special work in the removal of cattle from the drought-stricken region of Texas and Oklahoma, they assisted in bringing in 17,807 head of purebred beef cattle and 40,183 head of grades. There were 805 feeding demonstrations with beef cattle, with a total of 28,317 head involved. The county agents started 2,195 herds of beef cattle. They assisted farmers in bringing 42,864 head of hogs into the South for breeding purposes, and helped specialists to conduct 7,884 feeding demonstrations, involving 71,901 hogs. The special campaign for increased hog production asked for by the Government was conducted in all States. The allotted percentages of increase were fairly well met, Mississippi and Tennessee leading, each with a 20 per cent increase. The agents helped bring in 10,775 pure-bred sheep and goats, and 69,862 grades, and conducted feeding demonstrations on 367 farms, involving 8,026 animals. In addition, they started 3,526 new herds.

POULTRY WORK.—County agents assisted specialists in conducting poultry demonstrations on 4,623 farms, involving the feeding of 474,397 birds.

LIVE STOCK DISEASES.—To help farmers protect their herds against live stock diseases and pests the county agents induced farmers to secure the treatment of animals for diseases, as follows—2,391,842 head of cattle and 2,299,661 hogs. In this they personally treated 568,167 head of hogs for cholera while administering either the simultaneous or serum treatment, in most instances under authorization of the State live stock sanitary boards. They induced farmers to have 43,396 head of sheep and 43,242 head of horses and mules treated for diseases. The grand total of live stock so protected was 4,778,141 head. In addition to this, they helped procure the building of 2,219 dipping vats and 3,803 silos.

TICK ERADICATION.—The Bureau of Animal Industry, in cooperation with the various State live stock sanitary boards, has been conducting an intensive campaign for cleaning the South of cattle ticks. There were released from quarantine 67,308 square miles of territory during the year. More than half of the original quarantine area is now released. Mississippi was declared tick free and South Carolina expected to be released November 1, 1918. County agents everywhere have assisted the specialists in the necessary educational work and in stocking the country with improved animals after the ticks have been eradicated.

MANURE, FERTILIZERS, AND LIME.—The county agents conducted 63,085 demonstrations in the proper care and saving of manure on farms, estimated to involve over 10,000,000 tons. The county agents assisted farmers and farmers' organizations in the cooperative purchase of lime and in lime demonstrations, involving practically 1,000,000 tons. They gave specific advice to 223,979 farmers regarding the use of fertilizer and conducted 11,665 specific demonstrations. They also induced 2,156 communities or organizations of farmers to

purchase fertilizer cooperatively. The value of the fertilizer so purchased by these organizations was \$3,630,195, and the estimated saving due to cooperative purchasing was \$532,106.

GARDENS.—A part of the general work in the Southern States in 1918 was the campaign for home gardens. Other forces were in the field, but the county agents organized this movement in practically every county in 1918, and the success of the movement was due mostly to them. Special agents in charge of the garden work were appointed for the States of Alabama, Georgia, Louisiana, Maryland, North Carolina, Oklahoma, South Carolina, Tennessee, and Virginia. In all of the other Southern States the specialists in horticulture and the county and district agents conducted the campaign. Under war conditions this campaign was definitely aimed at city and town gardens as well as rural gardens. Complete data are not available, but it is estimated that a total of more than 3,000,000 gardens in the South were the result of this campaign.

COOPERATIVE MARKETING AND PURCHASING.—The statement often made that the colleges, the county agents, and the United States Department of Agriculture put all of their emphasis on production and are not assisting the farmers with the difficult problems of marketing may be answered by saying that the county agents have everywhere worked with bodies of farmers organized for the purpose of purchasing farm supplies and marketing farm products. Where the marketing problem has been critical, the county agents have not hesitated to quickly assist farmers and farmers' associations to organize on the proper basis for making purchases or marketing products. The South is just building its new agriculture, and in this building problem many difficulties regarding the marketing of the new products have arisen and all of the extension forces have realized that it was necessary to help farmers to solve these problems. This the marketing specialists and county agents are doing. The Bureau of Markets of the department has a specialist in marketing, either in direct or very close cooperation with the extension forces of the colleges, in the following States: Virginia, North Carolina, South Carolina, Georgia, Mississippi, Louisiana, Arkansas, Tennessee, and Kentucky.

There have been many reasons for greatly extending marketing efforts, as for example, the increased production of hogs and cattle in the South, the necessity for organizing new systems to take in farm products locally produced and distribute them to local markets, the increased production of food and feed which had to be distributed through local organizations, the drought conditions in western Texas and Oklahoma, and the Government sale of nitrate of soda.

The main items of business of this kind, in which the county agents assisted, were as follows:

Fertilizer, lime, and the like, purchased amounted to 64,382 tons valued at \$1,906,122, exclusive of nitrate of soda; carloads of cattle marketed 751, valued at \$1,034,295; carloads of swine marketed 1,530, valued at \$2,748,948; corn, wheat, and other grain marketed 1,395,960 bushels, valued at \$1,590,448; miscellaneous agricultural products marketed valued at \$2,631,985. The grand total value of

the work was \$17,156,232, and the saving \$2,834,067, or about 16 per cent.

HOME DEMONSTRATION WORK AND GIRLS' CLUB WORK.

The home demonstration work was organized for the purpose of giving the same service for women and girls on the farm which the county agent performs for the men and boys. It is organized as a definite part of the State extension service, and represents the cooperative effort of the State agricultural college and the United States Department of Agriculture, and counties and communities. In the majority of the States in the South the home demonstration division of the extension service carries the entire extension work for women and girls. The work is organized on much the same basis in all the States. There is a woman in charge of the work in every State. In Virginia, Tennessee, North Carolina, South Carolina, Georgia, Florida, Mississippi, Louisiana, Texas, Oklahoma, and Arkansas she is practically an assistant director, responsible to the director of extension, and in charge of the home demonstration work for women and girls.

Organization has been moving along rapidly. All extension agents recognize that an organization in the community, representing all the activities, is the ideal organization. The problem of county organization for extension work is discussed under the county agents' work (p. 367). The home demonstration work has been gradually fitted into the organization. In many counties either a women's section of the county agricultural council has been organized or a women's advisory committee has been established. In all cases the work is founded on community effort. The home demonstration work is organized on the basis of clubs of women and girls, often, though not always, representing a community organization.

The Southern States had last year 6,391 clubs of rural women, with a regular enrollment of 325,229 and an emergency enrollment of 1,518,746 women; 9,028 girls' clubs, with a regular membership of 146,102 and an emergency enrollment of 759,373; 1,563 clubs for rural negro women, with a membership of 37,913; and 1,822 clubs for negro girls, with a membership of 50,995. There was an emergency enrollment of negro women and girls in these clubs of 247,143, of which about one-third were girls and two-thirds women. In addition to these, there were 1,179 organized communities of city and town women in the urban work, with a regular membership of 119,218, and an urban enrollment among negro women in cities and towns of 224 clubs with a membership of 1,035. In addition to these, there were 2,751 poultry clubs of white women and girls, with a membership of 63,481, and there were 13,434 negro women and girls taking poultry work. This makes a grand total of 23,096 regular clubs of women and girls. The total regular and emergency enrollment was 3,283,669. A little over 2,000,000 of these are women and a little over 1,000,000 are girls. This represents the total number of people enrolled but does not represent the total number of persons reached, as it does not include those in attendance upon lectures, extension meetings, demonstrations, exhibits, etc., who were not enrolled in some club.

Such a large enterprise naturally resulted in many interesting and constructive pieces of organization work. In all of them the home

demonstration agent was represented and in most of them she was the leading figure. During the year 1918 in the 15 Southern States there were established 855 community canneries; 639 community demonstration kitchens, where women gathered to receive instruction; 131 community drying centers; 137 rest rooms in cities and towns for the benefit of farm women; 173 egg circles for cooperative sale of poultry and eggs; 211 cooperative breeding associations engaged in the improvement of poultry; and 20 free curb markets were organized where farmers and farm women and girls come to dispose of their products directly to housekeepers.

PURPOSE AND PLAN OF THE WORK.

The whole purpose of the work was to reach, through organization, the largest possible number of women and girls and give them direct assistance in problems of production, conservation, and utilization of food, and in the preservation of health, prevention of disease, introduction of labor-saving devices and home conveniences, beautification of the home and its surroundings, cooperative and individual marketing of products, and thrift and saving from the family income.

This program included gardening, canning, drying, and brining; production of butter and cheese for home use and for market; production and marketing of eggs and poultry; purchase and home manufacture of labor-saving equipment; home management; utilization of home-produced and other foods for a healthful diet; saving of wheat, meat, sugar, and fats; conservation of clothing; development of community enterprises, such as canneries, drying plants, demonstration kitchens for instruction, and curb markets; and cooperative marketing of products.

In all of this work there were three main objects—first, production; second, economy and thrift; and third, health. Along with the other work considerable attention was given to recreation, social enjoyment in the club meetings, and the general improvement of rural conditions.

RESULTS.

The total number of containers of vegetables and fruits put up during 1918, under the direction of the home demonstration agents, was 64,604,531, valued at \$15,566,456.15. The women enrolled as regular members of clubs, whose work was intensive and thorough, put up 23,528,345 cans, while the regular enrollment of girls put up 10,497,768 cans; 2,654,607 cans are to be credited to the urban work and 19,334,583 to the emergency enrollment. Rural negro women put up 1,073,663 cans and negro girls 430,314 cans; the city negro women 456,470 cans, and the negro emergency enrollment 2,344,776 cans. A very large proportion of the vegetables canned were produced from the home gardens and from the tenth-acre plats of the members of the girls' clubs. Eight hundred and fifty-five community canneries were established for operation on a cooperative basis. A great contribution to the food resources of the South was made during the war as a result of this work of the women and girls.

Besides the millions of home gardens, 91,000 demonstrations of winter and perennial gardens were established and conducted by women and girls to illustrate all-the-year-round food production.

It is difficult to say what proportion of the emergency work should be credited to the girls and what proportion to the women, but it is probable that about one-third of the emergency canning should be credited to the girls. In no other year in the history of the work in the South has so much been done along this line, and the results are to be attributed to the enthusiasm and energy of the agents and to the wonderful organization and devotion of the women and girls who contributed toward these results.

The work in home drying of fruits and vegetables for future use initiated in 1917, owing to the scarcity of cans, advanced very materially during the season of 1918. The total amount of dried fruits and vegetables prepared and stored was 8,932,787 pounds, estimated to be worth \$1,846,625.56. The women established 131 central plants for community drying.

The results in brining and pickling were beyond expectations, about 1,006,222 gallons of vegetables, valued at \$382,808.73 having been preserved and saved. Rural women in the regular enrollment put up 336,872 gallons, and in the emergency enrollment 447,292 gallons. The balance was put up by the girls and a small amount by the negro enrollment.

The agents' reports show that the women enrolled in the work in 1918 produced 16,507,711 pounds of butter and 939,603 pounds of cottage cheese. A considerable proportion of this butter was sold locally and brought an average of 17 cents per pound above the market price for ordinary butter.

During the year 1918 there were organized 173 egg circles and 211 cooperative poultry breeding associations. Through these organizations approximately 1,592,357 chickens were raised and 575,593 dozens of eggs marketed cooperatively and 198,427 dozens individually. The value of the eggs marketed was a little over \$300,000. They marketed 1,148,738 pounds of poultry, valued at \$311,558.82. The agents also report 130,297 dozens of eggs preserved in waterglass.

The home demonstration agents worked in close cooperation with the Food Administration in the conservation of wheat, meat, sugar, and fats, and deserve a fair share of the credit for the success of this campaign.

In addition to these lines of work, household conveniences, labor-saving devices, and equipment of various kinds were placed in thousands of homes, farm women and girls were assisted in the conservation of clothing, and many other things were done to improve the health, beautify the home, and make country life more attractive.

BOYS' AGRICULTURAL CLUBS.

The boys' agricultural club work surpassed all previous records. Stimulated by a spirit of patriotism and assisted by the emergency appropriation, the boys' club enrollment increased from 115,746 in 1917 to 407,540 in 1918, including the emergency members. The grand total production of the clubs, including emergency members and farm makers' clubs for negro boys, was \$12,034,271.27. The

average yield of corn grown by club members was 42.8 bushels, while the average for the Southern States was 19.4.

The demonstrative value of club work is being felt throughout the South. Boys' club work has not only gone a long way toward definitely directing and applying the rural boy power of the South into channels of useful work, but their intelligent application of experimental data has in many instances demonstrated to the adult farmer the value of improved methods.

EXTENSION SPECIALISTS.

The agricultural extension work centers around the county agent. It is through him that the great store of information regarding better farm practice is carried from the United States Department of Agriculture and the State agricultural colleges and experiment stations to the large body of farmers scattered through the States. It is also through him that the unsolved problems arising on the farm are brought back to the experiment stations and the department for their solution. It is obviously impossible for the county agent to have a broad enough knowledge of the various sciences necessary to solve, offhand, all of the problems arising in a county with its great variation of crops, live stock, soils, plant diseases, and the like. That the county agent may be able to assist in the solution of these problems, each State maintains a force of specialists whose duty it is to furnish the county agent definite information on matters pertaining to their particular line.

It is very gratifying that as the extension work progresses a better understanding of the relationship between the specialist, the county agent, and other extension workers has developed with it. It is being more clearly recognized that there must be a definite interlocking of the efforts of all members of the extension force if the organization is to function to the greatest advantage. To this end, in practically all cases, the specialist and the county agent are planning their work cooperatively. The specialist maps out, in project form, various kinds of demonstrations designed to meet the problems arising in his particular line. The county agent selects from these projects those particularly applicable to his county. The farmer who conducts the demonstration is selected by the community club or volunteers his effort for his own good and that of his neighbors. The selection is approved by the county agent and the specialist.

Specialists have also rendered effective service by speaking and giving practical demonstrations at meetings, arranging and looking after exhibits at fairs, and assisting in the judging of these exhibits.

NEGRO WORK.

Work with negroes was continued along the same general lines as in previous years with a small increase in the number of agents. As a rule the negro agent is appointed assistant to the white agent so that the regular county agent has general supervision of the work. In counties without negro agents the regular county agent does considerable work with negro farmers so that they receive the benefits of the extension work even though they have no agent working directly with them.

In most of the States, cooperative relations have been perfected between the negro agricultural colleges and the extension division of the college for whites. The negro in charge of the negro agents has his headquarters at the negro agricultural college. The work with negroes has been very effective in stimulating the production of home supplies, especially the home garden. In some States marked progress was made in encouraging negro farmers to keep a cow for supplying milk and butter to their families, and the raising of pigs to supply meat.

OFFICE OF EXTENSION WORK IN THE NORTH AND WEST.

C. B. SMITH, *Chief.*

ADMINISTRATION.

The Office of Extension Work in the North and West has charge of the cooperative extension work of the department in the 33 Northern and Western States. Its administrative duties, organization, and relationships were not materially modified during the year.

Many important administrative questions were handled. In the first few months these problems had to do with the organization and direction of war emergency extension activities, so that not only increased food production but also strict food conservation might be attained. In addition, methods of clothing conservation were given the careful attention they merited. All these activities were conducted in such a way that the permanent improvement of agriculture and home-making conditions, methods, and practices might result. After the signing of the armistice numerous problems arose out of the changed agricultural economic conditions, the return to a peace program of work, and the adjustment necessary because the special war emergency funds were not to be available after the end of the fiscal year.

Each of the Northern and Western States was visited as usual during the year and the expenditures of the Smith-Lever funds examined, conferences held with the extension director and his staff, and progress and plans of work discussed.

COUNTY AGENT WORK.

This section continued under the immediate charge of W. A. Lloyd. The number of counties employing agents on June 30, 1919, was 1,106, approximately the same as on June 30, 1918. In addition, there were 45 district agents, covering 105 counties, and 104 assistant county agents. The number of county agents reached its maximum about December 1, 1918, at which time there were 1,136 county agents, 52 agents in larger districts covering 156 counties, and 61 assistant county agents. At that time approximately 82 per cent of the agricultural counties in the 33 Northern and Western States were being reached. In a few counties where the work was started in cooperation with county councils of defense the county agents were discontinued shortly after the signing of the armistice because of lack of local funds.

COUNTY AND COMMUNITY ORGANIZATION.

The rapid appointment of agents during 1917 and 1918 made impossible thorough organization in many of the counties. The past year witnessed a great intensification of county and community organization. The development of community programs received special emphasis. The initiative and cooperation of the people of each community were carefully nurtured, and by conferences with community leaders local extension programs were developed. Although the number of county extension organizations did not increase materially from the 775 on June 30, 1918, the membership increased from approximately 300,000 on that date to 409,841 on March 1, 1919. More important, however, was the organization of community committees. No data are available as to the number of such committees on June 30, 1918, but it may be conservatively estimated that more than one-half of the 8,575 community committees existing on June 30, 1919, were organized during the past year. Better understanding was established and maintained with local farmers' organizations, and their machinery was freely lent to the furtherance of the extension program.

DEMONSTRATIONS.

Field demonstrations continued to be the basis of the work. Although during the summer of 1918 definite demonstration work was much interrupted by special or "war work," 77,668 demonstrations were conducted incident to crop and live-stock production. Almost every phase of agriculture where the need of more efficient production was apparent or made evident by a study of local conditions was touched.

The meeting at the demonstration plat is probably the most effective teaching agency. Through it farmers see the effect of the method or practice advocated and determine its application to their farms. During the year 677,653 people attended such demonstrations conducted by the county agents. The increased profit on demonstration areas alone, due to the better practices, amounted to \$22,206,307, or more than five times the total cost of the work.

WAR WORK OF COUNTY AGENTS.

The county-agent system was expanded as a food production stimulation measure through special funds appropriated by Congress. The county agents thus became the local agencies for propaganda work of this character by both the Nation and the States. A great number of other agencies also sought and secured cooperation.

The following is a partial list of the ways in which the county agents assisted the various departments of the Federal Government and others during the year 1918-19:

The agents secured information as to farm-equipment prices; made surveys to determine farm labor supply, financial condition of farmers owing to crop failure, increase in use of farm machinery, and use of tractors on farms; ascertained the number of farmers in each draft class and the surplus or shortage of labor in each class; assisted in arranging seed loans to farmers in drought-stricken areas in Mon-

tana, Kansas, and other States; placed farm help; and promoted campaign for standard width of farm vehicles. For the Bureau of Markets they made a survey to determine the amount of wheat and other cereals thrashed; assisted in securing reports from thrashermen, in wool marketing, and in collecting data regarding the price of wool and hides; made a survey of the retail markets; secured samples of spring wheat and lists of cheese factories; made a survey of the needs of farmers for nitrate of soda and distributed nitrate; collected data regarding the marketing of sweet potatoes and food supplies in homes; collected feed-supply reports; made a lime survey; redistributed sheep and cattle; facilitated wheat marketing; distributed information and gave assistance in connection with the shipping of potatoes; promoted storage of vegetables; and assisted in the movement of cattle from drought-stricken regions of Texas to Northern States. For the Bureau of Plant Industry the agents made surveys to determine the extent and damage of cereal and potato diseases, condition of the clover seed crop, number of farmers raising vetch, distribution of sweet-clover acreage, and acreage of war gardens; located, secured, and distributed seed corn; distributed and introduced new plants and disease-resistant seed; and assisted in control of white pine blister rust and barberry eradication.

The Bureau of Animal Industry was assisted by the agents in the control of animal parasites and hog cholera, in surveys of contagious diseases in cattle, in locating available supplies of alfalfa and clover hay, in the cottage-cheese campaign, in securing a list of sheep feeders, and in moving cattle from drought-stricken areas. The Bureau of Entomology was assisted in surveys to determine damage done by the Hessian fly, bean weevil, codling moth, and by insect pests of cereals, truck crops, and fruits; the presence of nematodes in grain; and the number of farmers keeping bees. The Bureau of Crop Estimates was assisted in securing crop reports, in the determination of winter and spring wheat acreage, in securing lists of buyers of farm products, and in making surveys of live stock and the pecan crop; the Bureau of Chemistry in carrying on potato flour experiments; the Bureau of Soils in making soil erosion and local price of fertilizer surveys, and in determining the need of farmers for potash; the Forest Service in encouraging the use of national forests for grazing, and in making surveys of land adjacent to national forests to determine the dependence of ranchers on forests; the Biological Survey in campaigns for control and eradication of gophers, jack rabbits, ground squirrels, moles, rats, and other predatory animals; and the Office of Farm Management in attending to many details in connection with the farm-labor survey.

The county agents assisted the War Department in securing castor-bean contracts, labor for construction of camps, and spruce for aircraft production; locating walnut timber; purchasing horses, mules, hay, and straw for the Army; collecting fruit pits for gas masks; considering deferred classification for farmers and soldiers' furloughs; placing conscientious objectors on farms; determining the number of farmers disabled by loss of limbs in operating farms; and securing list of shoe dealers.

They assisted the Treasury Department in miscellaneous activities connected with Liberty loan and war savings stamp campaigns; in

the influenza work of the Public Health Service; and in the organization of farm loan associations by the Farm Loan Bureau.

The employment service, the Children's Bureau, and the Labor Reserve of the Department of Labor were assisted by the agents.

For the Council of National Defense county agents made a survey to determine motor transportation routes; cooperated in thrift and conservation campaigns; made report of owners of thrashing outfits; assisted in distributing machinery, establishment of fair prices, and inspection of thrashing and routing of thrashing machines; and secured information regarding wool prices.

The Food Administration was assisted in taking a hog census; in determining prices of foodstuffs, dairy products, and dairy feed; in securing a list of bean growers; in obtaining data regarding milk production; in the food pledge campaigns; in the sale, sampling, and inspecting of beans and stimulating their production; in listing grist mills; in wheat inspection and grading; in food conservation campaigns and use of food substitutes; and in securing lists of stock feed used by farmers.

For the Fuel Administration the agents made surveys of materials used for fuel and secured lists of fuel dealers and public buildings using coal.

The agents cooperated with the agricultural development department of the Railroad Administration.

They made a survey of the price of farm machinery for the Federal Trade Commission.

The agents also assisted the Red Cross in making a survey of nurses and in its relief work and campaigns for funds, and a woman's organization in determining opportunities for work and organization.

CROP PRODUCTION WORK.

Special crop production campaigns were conducted in connection with most of the crops commonly grown, special attention being paid to stimulating increased acreage and locating and securing good seed. The table below summarizes some of this work.

Some results of the increased food production campaign of county agents.

Crop.	Farmers assisted in securing or locating seed.	Seed secured or located for farmers.	Additional area seeded as result of special campaigns.	Estimated total production on additional acres.
		<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>
Spring wheat.....	48,854	831,566	1,415,901	21,258,695
Winter wheat.....	28,963	1,119,163	2,724,561	23,902,678
Oats.....	14,142	421,660	182,507	4,893,610
Corn.....	222,123	1,232,099	597,720	12,820,300
Rye.....	11,532	183,595	258,790	1,705,806
Buckwheat.....	2,186	23,601	17,055	331,485
Barley.....	6,333	159,493	122,569	2,827,995
Potatoes.....	9,294	358,779	32,609	2,157,712
Beans.....	4,785	29,578	40,528	247,088
Total.....	348,212	4,359,534	5,392,240	70,145,369

CORN.—The unfortunate seed condition for two preceding years made special emphasis on seed selecting and testing necessary in the fall of 1917 and the spring of 1918. In the fall of 1917 county agents arranged for field selection on 326,662 farms involving sufficient seed for 3,466,986 acres. As the result of campaigns in the spring of 1918,

547,779 farmers tested seed and 10,605,894 acres were planted with tested seed. Reports from agents indicated a stand of corn much above the average in 1918. The seed selecting campaign was renewed in the fall of 1918 and resulted in the field selection of 4,718,691 bushels of seed. The county agents reported a total increased production of nearly 13,000,000 bushels as the result of all campaigns incident to corn.

OATS.—Ninety-seven thousand nine hundred and eighty-three farmers treated seed oats for smut following the agents' directions, and the total acreage seeded with treated seed amounted to nearly 2,000,000 acres. The increased net profit due to seed treatment averaged about \$2 per acre on several thousand demonstration fields where careful records were kept.

HOME AND COMMUNITY GARDENS.—Work in connection with home and community gardens was carried on in both town and country. More than 225,000 families were given direct assistance in connection with home gardens. No estimate is possible of the value of the increased food supply. As a by-product of these campaigns, however, 3,588,070 quarts of fruits and vegetables were canned and 753,389 pounds dried. The agents conducted 6,894 canning demonstrations and furnished information to 149,282 families in regard to storing fruits and vegetables.

LIVE STOCK WORK.

Assistance in sanitation and demonstration of disease control methods continued a prominent phase of the work with live stock. The work was done wherever possible in cooperation with local veterinarians and State and Federal control agencies, the county agent's part being to demonstrate the usefulness and helpfulness of approved methods. These demonstrations involved the testing of 55,962 animals for tuberculosis, and the vaccination of 380,264 animals for blackleg and 523,189 hogs for cholera.

FARM BUSINESS.

Seventeen thousand eight hundred and thirty-five farmers kept records of their business on blanks furnished by the State farm management demonstrators. The county agents assisted 6,860 of these in closing their accounts. Profitable changes in their farm management were made by 3,444 farmers as a result of records kept.

The county agents assisted in the organization of a large number of cooperative associations for buying farm supplies and selling farm products, and by cooperating with groups of farmers and other agencies in determining the cooperative enterprises needed and obtaining the expert attention necessary to put the enterprises on a sound business basis. The associations are followed up from year to year in an effort to prevent the mistakes which so often cause failure of such enterprises. The total value of cooperative business of farmers' exchanges and cooperative associations organized by county agents in this and preceding years amounted to \$41,877,783. The saving effected amounted to more than \$4,500,000. Three hundred and thirty-two Federal farm loan associations were organized by agents and 19,312 farmers were assisted in securing credit for the purchase of seeds, machinery, fertilizers, and other supplies. The

agents helped in meeting the labor situation by the locating of 151,532 men for work on farms.

In carrying forward the various projects and campaigns the agents made more than half a million farm visits, the average number of farm visits per agent being 435.

The spring of 1919 brought serious readjustment problems owing to the prospect of peace brought about by the signing of the armistice. These can only be worked out gradually, though in the main their solution appears to mean a return to normal farm practice with an emphasis on the organization of the farm as a profitably productive business.

EXTENSION WORK WITH WOMEN.

This work continued under the direction of Miss Florence E. Ward. The activities during the year were characterized in every phase by a transition from war-time problems to those of readjustment and peace.

ORGANIZATION.

On June 30, 1918, the home demonstration force in the field numbered 790, including 31 State leaders, 361 agents, and 32 assistant agents in counties, 98 agents in districts, and 107 urban and assistant urban agents. Of this number, about 100 were temporary appointments. On June 30, 1919, workers numbered 582, including 32 State leaders, 329 agents, and 21 assistant agents in counties, 22 district agents, and 98 agents and assistants in cities.

During the war agents were installed without any permanent organization in many counties and districts that provided the required sum for local expenses. Since the war fruitful efforts have been made to establish the agent as an employee of a permanent county organization in which women have membership and representation on the executive board. In 17 States the work is an integral part of that of the farm bureau; in some others it is conducted as a department of the farm bureau, called home department, women's department, or home bureau. In Illinois and Wisconsin it is organized apart from the farm bureau.

Progress was made in developing county and community programs of work, putting the work on a project basis, and training county and community project leaders. An outstanding feature has been the use of carefully selected and trained volunteer leaders in food production, food preservation, use of war substitutes, clothing, and poultry culling.

In some States, where county funds could formerly be appropriated only for county agent work, legislation has been enacted permitting appropriations for home demonstration work. In many counties the women themselves have secured a considerable increase in local funds necessary to continue the home demonstration work.

Home demonstration work in cities was considered a war measure and no permanent organization was at first attempted. Funds for local expenses were furnished by national, civic, or other organizations, and the agents cooperated with all existing organizations. With the signing of the armistice the development of permanent home bureaus was undertaken in many cases, and on June 30, 1919, there were 20 such bureaus in various stages of development, with

more planning to organize in the autumn. Like the farm bureau, the home bureau is based upon a program of work developed by the people of the community, with each project or activity of the program in charge of a community project leader. The home bureaus of Buffalo and Syracuse, N. Y., have paid memberships numbering 930 and 830, respectively.

Besides their emergency service as leaders in food preservation and conservation, urban agents made records along the lines of child feeding, clothing, and thrift work, cooperated in putting on far-reaching milk campaigns, and started canning kitchens, soup kitchens, milk stations, information centers, hot school lunches, and neighborhood centers that have been taken over by municipal authorities or welfare organizations. The most effective work seems to have been done with wives of wage earners, women of foreign extraction, and women employed in industry.

FOOD PRODUCTION, CONSERVATION, AND UTILIZATION.

For the year ended November 30, 1918, the State leaders reported 570 training classes for local leaders in food production and 12,960 in food preservation; 750,000 persons reached by lectures, demonstrations, and home visits; over 1,400 exhibits held; more than 100,000 home gardens planted; more than 100,000 pounds of cottage cheese made in homes; and a marked increase in the efficiency of home poultry flocks, through poultry culling. Food was preserved by those whom agents influenced as follows: 12,532,205 quarts of fruit, 2,572,757 quarts of fruit products, 8,982,461 quarts of vegetables, 269,717 pounds of meat, and 46,380 pounds of fish canned; 344,001 pounds of fruit and 804,565 pounds of vegetables dried; 2,200,000 quarts of vegetables brined; and 462,307 dozens of eggs preserved. Community food enterprises were established with the advice and assistance of home demonstration agents as follows: 445 canning kitchens, 33 drying establishments, and 93 demonstration kitchens used as instruction centers; 46 cooperative buying associations; 31 cooperative selling associations; 14 curb markets, with sales amounting to \$67,533; and 10 milk stations.

Home demonstration agents gave 27,000 lectures and demonstrations on food selection and the use of war substitutes, and made 37,663 home visits in this connection, reaching over 2,250,000 persons. In addition, they prepared 3,000 exhibits, attended by over 2,700,000 people.

After the armistice, the agents responded to the widespread demand for instruction in food selection, placing special emphasis on child feeding and hot school lunches.

MILK CAMPAIGNS.

Urban home demonstration agents in Michigan, Massachusetts, Connecticut, Rhode Island, and New Jersey, and rural agents in Iowa, Kansas, and Utah took part in vigorous milk campaigns carried on cooperatively with the Dairy Division of the Bureau of Animal Industry, the object being through educational work to stimulate the production and consumption of milk and milk products for human food. This project was timely in view of the records showing progressive malnutrition of children in the United States during the last few years. Records kept by schools showed the ef-

fects of an increased use of milk in the diet of undernourished children. Milk talks were given in factories and milk sales increased from 5 to 35 per cent, factory managers permitting distribution of milk at cost to employees during working hours. Stations for the distribution of whole and skimmed milk were also established. The board of health of New Haven, Conn., states that infant mortality decreased 50 per cent in the last year in one factory district in which such a station was established.

IMPROVED HOUSEHOLD EQUIPMENT.

Rapid progress was made in introducing homemade and commercial labor savers, including fireless cookers, pressure cookers, and iceless refrigerators. On December 1, 1918, the State leaders reported 228 water systems and 198 lighting systems installed, 4,281 houses screened, 1,002 kitchens remodeled, and 9,563 pieces of improved equipment installed as a result of the work of the home demonstration agents.

INFLUENZA SERVICE.

During the influenza epidemic, home demonstration agents were called on to assist in important emergency work, such as organizing soup kitchens (49 reported), emergency hospitals, and volunteer nursing services, or to act as hospital cooks and dietitians. Many agents organized classes in home nursing, in connection with State home nursing specialists, local nurses, or doctors, or the Red Cross nursing service.

POULTRY.

In Connecticut, Delaware, Idaho, Illinois, Missouri, and Vermont home demonstration agents played a prominent part in intensive culling campaigns inaugurated by Federal and State poultry specialists. In one county 250 women culled flocks totaling 23,550 birds, discarding about 40 per cent and saving \$19,000 on feed. Canning of surplus culls and preservation of eggs in waterglass were widely demonstrated. Agents also took up other phases of poultry work.

SPECIALISTS.

A member of the Washington staff delegated to study the work of home economics extension specialists visited 14 States and held conferences with State leaders and specialists and reported upon the work. Fifty home economics extension specialists were employed in 15 States to give instruction and demonstrations in foods and nutrition, clothing, home hygiene and sanitation, household management and conveniences, home decoration, and other subjects. An almost equal number of women who were virtually specialists assisted in such work in the 18 other States.

BOYS' AND GIRLS' CLUB WORK.

The boys' and girls' club work continued in charge of O. H. Benson. Marked progress was made during the year in the employment of paid club leadership. Twenty-eight State, 131 assistant State, 57 district, and 736 county club leaders were employed, in addition to which there were 13,988 volunteer club leaders in charge of local

groups. There was a steady tendency toward employment of full-time county club leadership. During the year 31 per cent of the 1,596 counties in the Northern and Western States had paid club leadership, and 21 per cent of all the counties had full-time county club leaders, where the previous year only 16 per cent of the counties had such leaders. The number of full-time county leaders on the rolls on June 20, 1919, was 272.

During 1918 cooperative club leaders conducted 31,336 demonstrations in food preservation and other club projects. At the canning-club demonstrations alone there was an attendance of 372,288. Club leaders visited 204,745 club plats, conducted 1,266 achievement-day programs, held 2,013 leaders' conferences, conducted 4,498 exhibits and 4,532 club fairs and festivals.

A large amount of instructional literature, issued partly by the States and partly by the department, was distributed.

One of the most significant and important steps in boys' and girls' club work during the year was the organization of standard clubs based upon requirements adopted by the club leaders. During 1918, 6,214 standard clubs were organized in 21 States.

During 1918, 527,723 members were enrolled in 21,345 centers, of which 251,032 completed the work, including reports of the season's activities to the State club leaders. The members reporting produced \$6,019,092 worth of products at a cost of \$2,447,313, including payment to the club members of wages for the time expended in the work. Many of the members who did not make their final reports did a considerable amount of work and produced several million dollars' worth of products. The total overhead or supervisory cost was \$547,851, making the supervision cost per member enrolled \$1.05 and per member reporting \$2.18.

The following table gives the number of clubs, the enrollment, the number reporting results, and the results in the more important projects:

Number of clubs organized and total enrollment and results reported in more important projects.

Kind of club.	Clubs organized.	Number enrolled. ¹	Number completing work. ¹	Results reported.
Home-garden.....	6,057	243,406	115,725	2,987,983.76 square rods tended.
Home-canning.....	3,898	78,927	41,823	1,901,789 quarts canned products, 133,067 jars jelly and jam, 40,784 pounds dried products.
Mother-daughter.....	235	5,024	3,498	26,175 quarts canned products, 29,437 jars jelly and jam, 2,125 pounds dried products.
Garment-making.....	2,356	38,239	18,951	198,822 garments made.
Poultry.....	2,171	37,723	16,128	331,072 chicks hatched, 40,735 hens handled, 133,565 dozen eggs.
Pig.....	2,331	31,476	12,974	25,602 pigs managed, 4,423,081 pounds pork.
Potato.....	1,240	23,316	11,307	3,184 acres tended, 646,503 bushels raised.
Bread.....	1,100	18,583	8,706	193,207 loaves baked.
Corn.....	841	13,864	5,723	6,729.02 acres tended, 313,778.78 bushels raised.
Home-economics.....	16	3,987	3,144	
Dairy calf.....	301	4,332	2,552	2,474 calves raised.
Sheep.....	257	3,613	2,341	
Sugar beet.....	98	1,822	1,398	
Rabbit.....	341	3,196	1,249	26,322 rabbits raised.
Bean.....	150	1,861	1,137	
Baby beef.....	162	2,469	985	1,011 beeves managed, 589,123 pounds beef.
Handicraft.....	84	2,131	488	
Miscellaneous.....	207	13,754	2,903	

¹ Includes also boys and girls not members of regularly organized clubs.

FARM MANAGEMENT DEMONSTRATIONS.

The primary object of farm management demonstrations is to teach and to induce farmers to adopt more efficient methods of organizing and administering their farm business. The work is directed in the different States by extension specialists known as farm management demonstrators.

In most of the Northern and Western States the operation of the income tax law has greatly stimulated the keeping of farm accounts. The farm management demonstrators have grasped this opportunity to push farm account keeping as rapidly as possible. In the main the work is being developed by the county agents. In States where the income tax law affects very few farmers the work has made steady growth and has been done with small groups. Many of the field men find that the best method is to work with small community groups. In States where the income tax law affects a greater number of farmers the farm management demonstrators have endeavored to reach the farmers through larger meetings or through the county agents. There is evidence that interest in the work is rapidly increasing and many more farmers are being assisted each year in summarizing their records both by the county agents and by the farm management demonstrators. During the year ended June 30, 1919, farm management demonstrations were conducted in 24 States by 28 demonstrators.

EXTENSION SPECIALISTS.

Extension specialists representing the various bureaus of the department, working in cooperation with this office, continued to study the extension methods practiced in the States and aided in extending the use of those having special merit. They also carried to the State extension specialists the best results of the research work of the department and endeavored to aid the latter in correlating subject matter and in working out with the county agents a more efficient means of reaching farm people with the desired information and in turn finding out the farm problems which should be brought to the attention of the research bureaus of the department of the State experiment stations.

Specialists of the following bureaus, offices, and divisions of the department cooperated during the year with the extension forces in the States:

The Forest Service made an application of approved forestry principles in the selecting of trees for cutting during the early part of the year while the wood fuel campaign was on and while the War Department was seeking gunstock and airplane timber.

Bureau of Animal Industry specialists encouraged the introduction of sheep into a few central States and on cut-over pine lands of the Upper Lake region, and the reestablishing of the sheep industry in New York and New England. Attention was given to the production of beef cattle by economical methods in the central western States. Organized campaigns for the culling of poultry to increase the egg supply and reduce the feed bills and better methods

of feeding were advocated for the increase of both the egg and meat supply. The Dairy Division through its extension specialist continued the cottage cheese production and consumption campaign of the previous year, and increased its efforts in the organizing of cow-testing associations, bull associations, and dairy manufacture. The specialists in charge of animal disease work were engaged particularly in educational methods for the prevention of hog cholera in many of the hog-producing States. These specialists were working in cooperation with the regulatory men and State extension services in assisting county agents in making demonstrations of control methods.

The specialists of the Bureau of Plant Industry continued the campaign to eradicate the common barberry to prevent rust on wheat and entered more vigorously into that against cereal smuts. This work was conducted by squads of demonstrators on seed treatment and barberry identification. One horticultural extension specialist assisted in the preparation of material for boys' and girls' garden clubs and in making a study of extension methods in conducting pomological extension work in the States. A specialist on vegetable gardening assisted in the preparation of material for boys' and girls' clubs and in making plans for the farmer's home garden. Some assistance was given by this person to the commercial growers and canners of tomatoes, peas, and other vegetables.

The Bureau of Biological Survey employed a specialist who conducted work in the Great Plains and the States farther west on the control of rodent pests in cooperation with the county agents and other State forces.

The Bureau of Entomology employed a specialist to conduct its emergency extension work in the control of insect pests and in the production of honey. Very successful campaigns for the control of crickets were carried on in Oregon and Washington and for the control of grasshoppers and chinch bugs in the Middle West and the Northwest. State extension specialists were cooperated with, as were also the county agents and the regulatory forces of the State, in developing plans for the control of grasshoppers.

The extension specialist in soils visited most of the States in the northern Mississippi Valley and the New England and Rocky Mountain States in the development of a plan of cooperation with the State specialists to increase the nitrogen and humus supply through the raising of more legumes in the crop rotation. He also made plans for extending the saving of manures and the use of green crops and other crop residues. He continued advocating the increased growth of nitrogenous crops to lessen feed bills and to increase the supply and improve the quality of manure.

The specialist representing the Bureau of Markets gave particular attention to the plans under which the marketing organizations of the States were working and to the formation of marketing routes or organizations.

The Office of Farm Management continued its cooperation with this office. The features emphasized in the work of the year were record keeping, the interpreting of the record, cost accounting, increased production per man, and labor distribution.

OFFICE OF HOME ECONOMICS.

C. F. LANGWORTHY, *Chief.*

The Office of Home Economics, developing the general policy followed in the previous year, adapted its work to the special war-time conditions and needs in question of dietetics and the conservation of materials and labor used in the household.

Special emphasis was placed on the work in experimental cookery, partly because during the first months of the year the need for using somewhat unfamiliar food materials required the development and popularization of methods and recipes adapted to such materials and partly because of the increasing demand for the standardization of cooking processes as a means to the better general utilization of food materials, fuel, and kitchen equipment. Much of this work was done in cooperation with or at the request of other bureaus or offices of the department or of other departments, notably the offices of extension work, the Bureau of Chemistry, the Bureau of Plant Industry, the Bureau of Animal Industry, the Bureau of Markets, and the Food Administration. The equipment of the experimental kitchen was increased to include different types of stoves, refrigerators, and other household conveniences so that varying home conditions could be reproduced and comparative studies made of the practical efficiency of different equipment and methods. The nature and results of the work of the experimental kitchen were in brief as follows:

(1) Studies of yeast breads brought out the detrimental effect of long kneading, particularly in the later stages of dough fermentation; several current recipes for yeast starters were tested.

(2) Studies in fuel conservation with gas range determined the losses caused by the common defects of having burners placed too far beneath the cooking utensil, and of having them too large in proportion to the size of the utensil; the claims of a commercial "gas-saver" were not substantiated; gas consumption in using small separate oven over top burner for baking was compared with that of the range oven.

(3) Household methods of making jellies, and of increasing yield from fruits deficient in pectin and in acid by addition of commercial and homemade pectins or of lemon juice or by use of pressure cooker, were studied and favorably reported upon. A study of yield showed that a pound of good jelly-making fruit should yield a pound or more of jelly.

(4) Studies in pastry making emphasized the fact that to be of good quality an economical paste must have water reduced as well as fat, and that vegetable oil can be used for pastry if care is taken not to use too much fat.

(5) Cake making with various oils and other fats demonstrated that baking at temperatures high enough to produce "lumpy cake" (a common fault) causes an increase of gas consumption of about 50 per cent, which is worse than wasted.

(6) A study was made of methods of canning vegetables, especially spinach, and of the rate of heat penetration in processing.

(7) Investigation of various methods of cooking dried fruits and vegetables revealed the fact that in almost all cases preliminary soaking is unnecessary and sometimes distinctly disadvantageous. Observations were also made upon the varying degrees of rapidity with which successfully-dried vegetables gradually lose their color and flavor upon aging, no spoilage having taken place.

(8) Outlines designed to facilitate standardization of methods in experimental cookery were prepared and distributed for use in colleges offering courses in that subject.

(9) Studies in absorption of fat by batters and doughs fried under varying conditions were carried on with a view to controlling this important source of waste.

Experimental studies on the digestibility of various foods were continued. The materials studied included various kinds of wheat flours; wheat bran in a diet containing no wheat flour; water-ground buckwheat; kafir corn milled in specified ways (showing that grinding increases digestibility); soy bean and peanut press cakes (showing them to be nutritious foods as regards composition and digestibility); certain meats concerning the food value of which little reliable information has been available (horse meat, corned seal hams, rabbit, and kid, all of which were assimilated in much the same degree as comparable meats); miscellaneous animal and vegetable fats; and hydrogenated oils.

Various methods were developed for making technical information along the lines of home economics easily available to extension workers and housekeepers, such as a formula by which the food value of a list of foods can be easily and quickly computed and the proper combinations determined; and a series of colored charts showing in attractive pictorial form the groups of foods necessary in an adequate diet and how they may be chosen and combined to make nutritious, palatable, and economical meals. Plans were also worked out for mimeographed loose-leaf notebook information on home economics subjects for the use of home demonstration agents.

In connection with a dietary survey undertaken in cooperation with the Bureau of Markets, 2,000 dietary records, each covering a period of 7 days, were collected from 1,425 families and 575 institutions representing 46 States, 16 nationalities, many occupations and incomes, and both urban and rural conditions.

From a summary of 500 of these family records it appears that the average cost of food per man per day was 46 cents, with an average return in food value of 3,225 calories, 96 grams protein, 118 grams fat, and 405 grams carbohydrate, figures in fairly close accord with the dietary standards ordinarily used in discussing such problems of general nutrition. A comparison of the foodstuffs purchased by the present 500 families with the amounts of these same foods purchased by 400 families about 20 years ago shows that the amount of meat in the diet has decreased about 8 per cent and grain products about 11 per cent, while dairy products have increased about 6 per cent, vegetables 4 per cent, and fruits 8 per cent. While, judging by these studies, the average diet seems to be adequate, it seems fair to conclude that individual food habits need to be corrected, because out of 500 family studies one-third were getting less than 88 grams of protein and 3,000 calories of energy, values which are considered the minimum for safety.

A different type of survey undertaken, the results of which were tabulated and interpreted during the year, is the so-called household labor survey, made in 91 farm homes in St. Joseph County, Mich. This survey was intended to secure reliable information regarding problems of household management and labor with their important bearings on social and economic conditions, and also to develop methods for similar surveys elsewhere.

Only one-fifth of the farm women represented in this survey hired help at any time, two-thirds depended upon the help given by members of the family, and one-tenth stated that they had no help. The average length of a farm woman's day in this locality was 13 hours in summer and 10 in winter, including time spent at meals. They estimated that they had one and one-half hours of leisure daily in summer and two and one-half in winter. More than one-fourth of the women took no pleasure trips by automobile or train during the year, the others took trips averaging 55 miles. On only 3 farms did the men have the entire care of the poultry, while 69 per cent of the women cared for it all of the year. In 2 of the 3 areas surveyed 73 per cent of the women helped

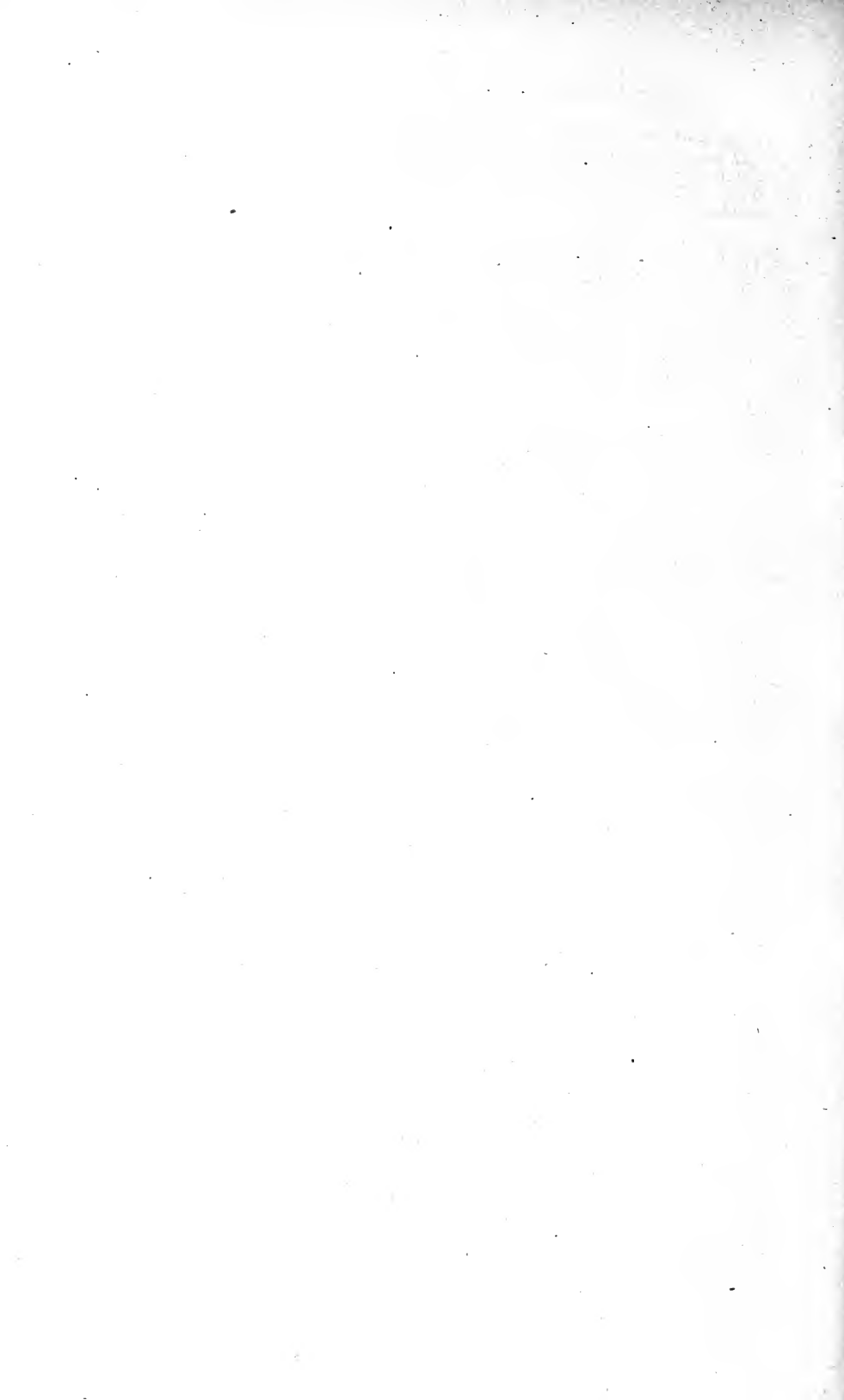
all or a part of the day with farm work during the busy season. Twenty-four out of 27 reporting depended upon the "butter, poultry, and egg money" to furnish the food purchased, household supplies, and part of the family clothing. Only 6 out of the 69 reporting had a bank account, separate from the husband's, for household expenses.

A significant feature of the work with the respiration calorimeter was that done in cooperation with the Bureau of Markets on the specific heat and after-ripening changes of fruit, with special reference to problems of commercial cold storage, in connection with which important improvements were made in the cooling system of the calorimeter. A special respiration apparatus was also devised and constructed for continuation of the cooperative investigations with the Bureau of Entomology on the wintering of bees.

A member of the staff was detailed to assist the Council of National Defense in its food conservation and general thrift work, and 20 so-called United States Thrift Leaflets intended for wide free distribution were prepared to aid the Treasury Department in its educational campaign in wise spending.

Besides bulletins reporting the work of the office, various circulars, popular articles, and mimeographed matter were issued.

The results of the work of the office were brought to the attention of the public not only through publications, but also by correspondence, conferences, and similar ways. This feature of the work has grown to be one of the most effective means of securing and maintaining direct contact with individual housekeepers, teachers, extension workers, and others, the helpfulness of which was especially demonstrated during the war.



REPORT OF THE CHIEF OF THE BUREAU OF PUBLIC ROADS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PUBLIC ROADS,
Washington, D. C., October 15, 1919.

SIR: I have the honor to submit herewith the Report of the Bureau of Public Roads for the fiscal year ended June 30, 1919.

Respectfully,

THOS. H. MACDONALD,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

WAR ACTIVITIES.

NUMBER AND PERCENTAGE OF EMPLOYEES IN MILITARY SERVICE.

At the time the United States entered the war there were on the rolls of the Bureau of Public Roads 189 men. Of this number, 79, or 42 per cent, had entered the military service when hostilities ceased in November.

There was also one woman from the bureau who entered the naval service as a landsman.

Of the total number who entered the military service, 61, or 32 per cent, have returned to the bureau. There are 4 who gave their lives for their country:

Harris E. Petree, who was a clerk in the bureau, went into the aircraft service as a private, was promoted to first lieutenant, and killed while making a flight back of the German lines on September 26, 1918.

Percy A. Rideout, a junior highway engineer, entered the service as a private and was promoted to first lieutenant. He was killed in action on the Verdun front, France, October 8, 1918.

Willis E. Comfort, a drainage engineer, was appointed as a lieutenant with the first expedition to be sent to France in 1917. Later he was promoted to captain and was killed in action near Soissons on July 18, 1918.

William Brown, auditor in the district office at Portland, Oreg., was called for service in June, 1918, and died of influenza at Camp Meade, Md., October 2, 1918.

The bureau is honored that these men were among those who went out from its service, loyal and unafraid, when the call came to the greater service.

ENGINEERING ASSIGNMENTS TO ARMY POSTS AND CAMPS.

Eighteen engineers were detailed by the bureau to prepare plans and superintend the construction of roads in the 16 National Army cantonments and one National Guard mobilization camp, located as follows:

Camp Devens	Ayer, Mass.
Camp Upton	Yaphank, L. I.
Camp Dix	Wrightstown, N. J.
Camp Meade	Admiral, Md.
Camp Lee	Petersburg, Va.
Camp Jackson	Columbia, S. C.
Camp Gordon	Chamblee, Ga.
Camp Sherman	Chillicothe, Ohio.
Camp Taylor	Louisville, Ky.
Camp Custer	Battle Creek, Mich.
Camp Grant	Rockford, Ill.
Camp Pike	Little Rock, Ark.
Camp Dodge	Des Moines, Iowa.
Camp Funston	Fort Riley, Kans.
Camp Travis	San Antonio, Tex.
Camp Lewis	American Lake, Wash.
Camp McClellan	Anniston, Ala.

The assignment of these men occurred in July, 1917, and the period of their assignments varied from three months to a year or more. The total construction planned and supervised by these engineers aggregated several hundred miles and included practically all types of construction, from sand-clay to first-class bituminous surfaces and concrete roads.

In addition to this work other activities in road construction not heretofore separately mentioned are as follows:

Roads were planned and their construction supervised for the Marine Corps at Quantico, Va., and for the Bureau of Ordnance at the Edgewood Arsenal, Gunpowder, Md., and outside of cantonments, usually from the cantonment to a city in the vicinity at the following places: Alexandria, Va., to Camp Humphreys; Alexandria, La., to Camp Beauregard; Little Rock, Ark., to Camp Pike; Columbia, S. C., to Camp Jackson; Spartanburg, S. C., to Camp Wadsworth; Greenville, S. C., to Camp Sevier; Petersburg, Va., to Camp Lee; Anniston, Ala., to Camp McClellan.

Several of the above projects were carried out in cooperation between the Federal Government and the State highway departments under the Federal aid road act of 1916.

ENGINEERING ASSIGNMENTS TO SPECIAL INVESTIGATIONS FOR OTHER FEDERAL BRANCHES.

One engineer was loaned to the United States Housing Corporation as consulting engineer on roads and streets necessary in connection with housing developments. This assignment was made in July, 1918, and the engineer gave his entire time to the work until shortly after hostilities ceased.

One highway engineer was detailed to assist the Emergency Fleet Corporation in planning roads and streets in connection with shipyard developments. He gave his entire time to this work from March 5, 1918, until after the ceasing of hostilities.

Complete and detailed highways maps were made, utilizing as far as practicable topographic sheets of the United States Geological

Survey, covering all of Maryland east of the meridian passing through Washington, all of the coast counties of New Jersey, all of Florida south of Jacksonville. These maps were delivered to the Corps of Engineers. In addition to these detailed highway maps, the principal highways in a zone extending from Boston to Newport News, through New York and Washington, were plotted on topographic sheets for the use of the Geological Survey in the preparation of aeroplane maps. Detailed route maps were prepared covering the army truck route from Detroit to Baltimore, this work being done in cooperation with the United States Geological Survey and the Corps of Engineers.

At the request of the Frankford Arsenal, Philadelphia, this bureau worked on a device for testing the power of explosives, with the idea of obtaining autographic record of the force and speed of the explosive.

Our large Page impact machine was borrowed by the American University for research work in connection with high explosives. At the present time impact machines of the type employed by this bureau are being used in practically all of the arsenals throughout the country in their routine investigations of explosive materials.

In cooperation with the concrete ship department of the Shipping Board this testing laboratory of this bureau was requested to make several series of tests in order to obtain desired information permitting of the safer design of reinforced concrete ships.

TECHNICAL INVESTIGATIONS AND TESTS RELATED TO WAR PROBLEMS CARRIED ON BY THIS BUREAU.

In view of the uncertainty of the protection of the steel by the concrete against the action of salt water, tests were made with bars coated with various kinds of paint coatings and metal coating to determine (a) the protection offered by these coatings against corrosion, and (b) the effect of the coatings on the bond strength. Some 24 coatings were tested, involving about 250 specimens.

In the design of a concrete ship the shear stresses are very high, and in order to use as little steel and concrete as possible it was necessary to use very much higher unit stress in shear than in ordinary reinforced concrete construction. As no test results were available to indicate what would be a safe unit stress to use with the exceedingly rich mixture of concrete, it was necessary to make a number of beam tests to determine this point. The materials were supplied by the Shipping Board.

Because of the extremely thin walls containing a large percentage of reinforcing steel, it was necessary to determine how best to pour the concrete so that it would entirely surround the steel and form smooth surfaces and yet be of consistency dry enough to produce the densest possible concrete. A specimen resembling the shell of a concrete vessel was made up and concrete was poured into the form and the form rapidly vibrated by hammering the sides. The forms were later stripped off and the specimen observed. The first method of pouring was a complete success and no further experiments were necessary.

Assistance was given to the Bureau of Standards in the pouring of a large reinforced concrete specimen designed to resemble

a concrete bulkhead for use in producing water-tight compartments in steel vessels. This specimen was 18 feet high and some 6 feet wide. During the pouring measurements were taken of the pressure exerted by the concrete against the forms, using the soil pressure cells designed in this bureau.

A series of tests was started in order to determine the pressures exerted by concrete poured so as to fill the forms at different rates. This information is useful in permitting of the economical design of the wooden forms.

There are many sections in reinforced concrete ships where the concrete can not be poured continuously, but where it is necessary to join the old concrete to the newly poured concrete with as strong a bond as possible. A number of different methods for obtaining a strong bond were investigated.

In connection with tests made at other laboratories for the Shipping Board, it was necessary to have instruments that would register exceedingly minute changes in length. At the request of the Shipping Board this office made three such test instruments after designs furnished by the Shipping Board. The Invar steel for the sides of these instruments was furnished by the Shipping Board, as were also the Ames dials. These instruments are proving very satisfactory.

THE UNITED STATES HIGHWAYS COUNCIL.

The first regular meeting of the United States Highways Council was held in the office of the Director of the Bureau of Public Roads at 10 a. m. Saturday, June 8, 1918.

Present: Mr. L. W. Page, Office of Public Roads, designated by the Secretary of Agriculture; Lieut. Col. W. D. Uhler, War Department, designated by the Secretary of War; Mr. G. W. Kirtley, Railroad Administration, designated by the Director General of Railroads; Mr. Richard L. Humphrey, War Industries Board, designated by chairman of War Industries Board; Mr. C. G. Sheffield, Fuel Administration, designated by the Fuel Administrator; and Mr. S. L. Selden, Capital Issues Committee, designated by the chairman of the Capital Issues Committee.

Permanent organization was effected by the selection of L. W. Page as chairman and J. E. Pennybacker, of the Bureau of Public Roads, as secretary.

Between this date and November 11, 1918, 25 meetings of the council for the transaction of business were held. On November 13, 1918, a special meeting was held at which the council announced "that no further applications need be made to it for highway projects; that previous disapprovals are revoked and pending applications require no further action. Procedure in securing materials for transportation should follow normal practices."

SUMMARY OF APPLICATIONS.

From the first meeting, June 8, to the last meeting, December 31, 1918, the full council held 27 meetings and the subcommittee 112 meetings. These meetings were in addition to the excellent and continuous service rendered by Mr. Prevost Hubbard and Mr. M. O. Eldridge as a special subcommittee.

Applications for approval, including those which had been submitted to the Office of Public Roads prior to the establishment of the council, reached a total of 7,307. Many of these applications were considered several times by reason of requests for reconsideration or by reason of requirements by the council of further information, so that the total number of considerations aggregated 9,712. No statement as to the exact number of approvals or disapprovals can be given, as many cases were merely deferred and not disapproved, others were conditionally approved or disapproved, others were reconsidered, and still others were affected by an amendment issued September 26 by the War Industries Board to circular 21 permitting the completion to November 1 of projects substantially under way. Still other projects were pending at the time the council ceased its activities, and in consequence it is impossible to segregate those applications which might be considered as definitely disapproved. A quantitative table dealing with the materials, transportation, and funds involved and showing such proportion as had been definitely approved has been prepared, however, and is submitted as follows:

Item.	Unit.	Requested.	Approved.
Capital issues ¹	Dollars.....	49,538,075	7,334,821
Road oil.....	Gallons.....	68,280,401	44,269,826
Tar.....	do.....	56,603,832	53,533,441
Asphalt.....	Tons.....	190,207	159,475
Cement.....	Barrels.....	5,657,390	2,139,769
Brick.....	M.....	109,125	52,239
Steel, structural.....	Pounds.....	10,663,250	694,820
Steel, reinforcing.....	do.....	22,281,275	3,231,301
Crushed stone.....	Tons.....	3,639,819	1,827,795
Gravel.....	do.....	1,204,552	432,707
Sand and screenings.....	do.....	2,216,481	982,479
Slag.....	do.....	520,152	250,428
Corrugated-iron culverts.....	Linear feet.....	107,815	23,704
Piling, timber.....	do.....	164,102	43,558
Pipe, vitrified, drain.....	do.....	2,165,419	99,699
Pipe, cast-iron, drain.....	do.....	47,052	43,740
Lumber.....	Feet b. m.....	5,530,116	1,651,635
Granite blocks.....	Blocks.....	1,420,500	156,500
Miscellaneous.....	Tons.....	123,206	49,513
Cars, open top.....	Cars.....	55,059	26,361
Cars, box.....	do.....	8,543	3,376
Cars, flat.....	do.....	3,705	605

¹ Includes applications acted on by Bureau of Public Roads prior to formal organization of United States Highways Council. Requested \$28,748,054, approved \$3,114,381. The Capital Issues Committee has jurisdiction and the Council served merely as an aid to the committee.

THE FEDERAL AID ROAD ACT.

LEGISLATION.

A careful canvass of all the State highway departments made after the original Federal aid road act of July 11, 1916, had been in effect for more than two years, indicated clearly that there were three limitations which were preventing this law from becoming an effective method of procedure between the Federal Government and the individual States. In its conception this law was founded upon the principle of cooperation for the purpose of stimulating road production and of supporting and aiding the States in their individual efforts, but it was found that practically all of the States were limited in proceeding along the lines of an adequate program: (1) By the post road requirements; (2) by the limitation of Federal participation to

\$10,000 per mile; and (3) by the amount of the appropriation carried.

These features of the law were handicapping practically all of the States very seriously. Anyone who is familiar with the rural free-delivery routes as now laid out knows that the mail carrier pursuing his zigzag route does not in many cases follow throughout their length those roads on which traffic is concentrating more and more, and which must therefore receive the first attention from the State road authorities. Improved highways will become one of the greatest possible advantages to the Postal Service, but this will require a rearrangement of routes as the roads are improved. The logical and systematic preparation of the eventual roads suited to rural mail purposes, therefore, requires much flexibility in the law providing Federal aid for road improvement.

The limitation of \$10,000 per mile for Federal participation was reasonable when the law was conceived during 1915 and the early part of 1916, but at the time of the passage of the act the cost of road construction was mounting rapidly, and by the year 1918 the provision under which the Federal Government offered to pay 50 per cent of the cost of the roads and the limitation of \$10,000 per mile could not both be applied in the construction of the higher type roads. The amount of the funds carried by the original appropriation was thought entirely sufficient to start the Federal aid cooperative program. At the time these sums were fixed, however, it could not be foreseen how enthusiastically the proposal of the Federal Government would be received by the public generally. The States were embarrassed by applications for Federal aid which the original allotments could not supply, and by the appropriation of sums so much greater than the amount necessary to meet the Federal aid appropriation that the whole plan in the fall of 1918 was in a most disappointing status. All of these objections were met in an entirely acceptable manner by the amendments to the original act carried in the Post Office appropriation act of February 28, 1919 (H. R. 13308). The definition of the term "rural post road" was so broadened as to permit the improvement of roads which could not qualify under the original definition. The maximum amount which can be paid by the Federal Government was increased to \$20,000 per mile, exclusive of the cost of bridges of more than 20 feet clear span. The increase in the share of the costs which may be paid by the Federal Government meets fairly well the demands of the several States in that respect. At the suggestion of the Secretary the original appropriation of \$75,000,000 for Federal aid roads available for the five-year period, 1916-1921, was increased by \$200,000,000, of which \$50,000,000 was available at once, \$75,000,000 on July 1, 1919, and \$75,000,000 on July 1, 1920.

NEW REGULATIONS.

The Rules and Regulations for the administration of the Federal aid road act as authorized by section 10 were originally issued by the Secretary on September 1, 1916. While these were drawn after a conference with the State highway officials, in which more or less conflicting views were expressed, it required the light of actual experience to disclose the principal difficulties which existed and which

prevented the fullest cooperation with the States. After more than two years' experience a canvass of the States indicated that the principal causes for disagreements or delays in the original Rules and Regulations could be summarized under the following points:

1. Conflicts with the State laws or State constitutions.
2. The limitations as to the expenditure of Federal aid funds for certain costs entering into completed roads.
3. The details of the plans, specifications, and survey requirements.
4. Adherence to standard specifications in specific instances in which economy prompted modifications.
5. Difficulties or delays encountered from inception of projects to final completion, in many cases resulting partially from overcentralization and lack of authority vested in the district engineers or the local representatives of the bureau.

Practically all of the complaints or misunderstandings voiced by the States were subject to classification under one of these causes, and it will be apparent that these difficulties were greatly accented by the new and untried State legislation enacted in every State and by the new and enlarged organizations required on the part of the States and the Federal bureau itself.

During the last fiscal year several minor amendments were made. At the December, 1918, meeting of the State highway officials the subject was thoroughly discussed and a general revision of the rules and regulations at once undertaken. These were completed after the amendment to the Federal-aid road act of February, and on March 12, 1919, the rules and regulations were issued. As revised, these rules and regulations have been generally accepted as satisfactory by the State highway departments.

These rules and regulations, however, must be regarded only as an instrument to facilitate road production under laws in force, whether State or Federal, relating to the Federal-aid road work. Several modifications of present procedure are now in contemplation for the purpose of facilitating and expediting action, and whenever it becomes apparent that revisions can be made which will result in economy of either time or effort, in so far as such modifications are legally possible, recommendations will be made for further revision to the secretary forthwith.

RESPONSE OF STATES TO THE FEDERAL AID ACT.

The Federal aid act inaugurated a plan of road improvement that has met with a remarkable response on the part of the public. Very few of the States were in a position to act until the winter of 1917, because of the need of new legislation and the appropriation of funds to meet the Federal-aid allotments. In April of that year war was declared, with its attendant concentration of effort to the one object. Highway construction throughout the country was necessarily and unavoidably restricted and confined to the more vitally necessary projects during this period. It was not until after the signing of the armistice in November, 1918, that plans were formulated for the resumption of the work which had been brought almost to a stop. But during that period the attitude of the public underwent a great change. The experiences during the war had crystallized public sentiment in favor of an improved system of highways to supplement the transportation facilities afforded by the railroads of the country

and to replace the roads which had suffered to such a material extent by the unforeseen traffic which had been forced upon them. The necessity for extensive road improvement was impressed more forcibly upon the public mind by reason of the demonstrated inadequacy of the system of railroad transportation and by the difficulties experienced when, in an endeavor to relieve the railroads, an attempt was made to utilize in a large way the highways in some sections of the country.

That the public is generally supporting a greatly enlarged program of highway construction is evidenced by the fact that up to July 1, 1919, bond issues aggregating \$224,800,000 had been authorized and approved by vote of the people. Provision has also been made in other States for submitting to a vote during the calendar year additional State highway bond issues amounting to more than \$314,000,000. Only one State road bond issue voted on during the year was rejected. In addition to the sums which become available through the sale of bonds, other State road funds have been provided from legislative appropriations, various State road tax levies, and the proceeds of motor vehicle license fees. In addition to these generous State road funds, counties and improvement districts are providing largely through bond issues for very large amounts. From all sources there are in sight funds amounting to considerably over \$1,000,000,000 for highway construction, which will be made available more rapidly than such sums can be expended efficiently and economically. The test of the State highway departments and of the Federal bureau will come in so administering the expenditure of these sums that the confidence of the public will be justified. It is very apparent that the whole highway program has passed beyond the propaganda stage, and that there is now the greatest possible need for the highway organizations to approach the task of actual road building in a responsible, sane spirit that will result in the production of roads rapidly but without extravagance and without loss of faith on the part of the taxpayers.

STATUS OF FEDERAL AID ROAD WORK.

Of the post road appropriations made by the Congress there was available during the fiscal year a total of \$80,000,000, the same being the sum of the appropriations for the fiscal years 1917, 1918, and 1919. From this there was deducted the 3 per cent allowed by law for the administrative purposes and the remainder, or \$77,600,000, was apportioned among the several States. Of this sum there was paid to the States during the fiscal year for road construction work a total of \$2,702,247. At the close of the fiscal year 1918 there had been paid to the States \$425,445. So that the grand total of all payments to the States on June 30, 1919, was \$3,127,693, which left to the credit of the States an unexpended balance of \$74,472,306. In addition, the \$95,000,000 appropriated for the fiscal year 1920 was apportioned to the States, after deducting the 3 per cent for administrative purposes, and that sum became available with the close of the fiscal year. On July 1, 1919, therefore, there was available to the credit of the States for expenditure a total of \$166,622,306.

During the fiscal year this department approved project statements submitted by the States for 736 road projects, involving the improve-

ment of 6,470 miles of road at an estimated cost of \$91,495,797, and on which \$38,664,397 Federal aid was requested. Up to June 30, 1918, 580 project statements had been approved for 6,249.40 miles of road, estimated to cost \$42,278,770, and on which was requested \$16,049,821 Federal aid. So that on June 30, 1919, there had been approved by this department project statements for a total of 1,316 projects, involving 12,719.98 miles of road estimated to cost \$133,774,568, of which \$54,714,219 in Federal aid was requested. At the close of the fiscal year, therefore, there remained to the credit of the States an unallotted balance, including the additional funds which then became available, of \$111,908,087.

Agreements with State highway departments were executed during the fiscal year to cover 453 of the projects for which project statements had been approved. The estimated cost of the projects covered by these agreements amounted to \$41,598,209, of which amount there was set aside in the Treasury \$18,031,680 as Federal aid. At the close of the fiscal year 1918 there had been executed a total of 224 such agreements of an approved estimate of cost of \$14,820,633, of which there was set aside in the Treasury \$5,899,936. Thus, at the close of the fiscal year 1919 a total of 677 agreements to cover projects had been executed, involving a total approved estimate of cost of \$56,418,843, and a total of \$23,931,617 Federal aid. The projects for which agreements had been executed at the close of the fiscal year call for the improvement of a total of 5,791.23 miles of road.

Under the terms of the Federal aid road act the apportionments to the States for each fiscal year remain available for expenditure until the close of the succeeding fiscal year, but it is construed that funds covered by agreements are expended within the meaning of the law. Each State had a sufficient amount of funds under agreement at the close of the fiscal year to prevent its losing any part of the funds apportioned to it.

Statistical information is shown in the following tables as to the status of Federal aid projects, the miles and types of roads included in Federal aid projects, and the expenditure and construction of roads during the fiscal year:

Summary of miles and types of roads included in Federal aid projects executed during fiscal years 1917, 1918, and 1919.

Type.	Mileage approved.	Per cent of total.	Total cost.
Earth.....	1,622.520	28.02	\$6,645,244.86
Sand-clay.....	626.705	10.83	2,657,970.03
Gravel.....	1,601.744	27.67	10,238,677.92
Macadam.....	163.512	2.82	1,823,550.67
Macadam mat top.....	170.078	2.94	1,275,712.95
Bituminous macadam.....	126.204	2.18	3,106,967.48
Bituminous concrete.....	118.170	2.04	2,821,214.59
Concrete.....	560.325	10.20	18,172,084.19
Brick.....	66.828	1.15	2,845,429.91
Miscellaneous.....	37.791	.65	189,614.53
Undetermined.....	665.992	11.50	6,925,839.97

Federal-aid expenditures and related data for fiscal year 1919.

Date.	Projects under construction.	Federal aid paid during month.	Total Federal aid paid to end of month.	Total number of projects completed to end of month.	Total Federal aid paid on completed projects.	Mileage of completed projects.
To June 30, 1918.....			458,757.60	5	166,274.84	17.643
July, 1918.....	155	114,376.64	573,134.24	6	208,996.38	21.643
August, 1918.....	193	179,303.58	752,437.82	6	208,996.38	21.643
September, 1918.....	243	196,426.51	948,864.33	6	208,996.38	21.643
October, 1918.....	279	253,529.79	1,202,394.12	11	264,690.25	47.677
November, 1918.....	269	285,940.24	1,488,334.36	11	264,690.25	47.677
December, 1918.....	281	311,751.08	1,800,085.44	12	284,690.25	51.087
January, 1919.....	300	296,014.59	2,096,100.03	16	461,521.81	61.157
February, 1919.....	312	263,760.91	2,359,860.94	24	566,665.13	79.481
March, 1919.....	312	263,591.52	2,623,452.46	31	702,194.88	116.896
April, 1919.....	341	69,038.88	2,692,491.34	31	702,194.88	116.896
May, 1919.....	420	159,176.37	2,851,667.71	35	784,699.84	148.102
June, 1919.....	566	401,807.81	3,253,475.52	38	828,363.30	184.315

¹ A number of projects closed down for the winter.

Summary of project statements approved and project agreements executed.

Year.	Project statements approved.			Project agreements executed.		
	Number of projects.	Estimated cost.	Federal aid requested.	Number of projects.	Estimated cost.	Federal aid.
Reported for fiscal year 1917....	23	\$1,845,433.60	\$846,151.84	6	\$547,092.25	\$224,717.20
Reported for fiscal year 1918....	557	41,053,200.67	15,478,089.66	218	14,239,939.15	5,658,458.42
Now reported for fiscal year 1919.....	736	91,495,797.99	38,664,397.41	454	41,631,731.67	18,048,441.97

NOTE.—The figures here given for the fiscal years 1917 and 1918 are from the annual reports for those years. As projects are modified from time to time, a project occasionally withdrawn, etc., sums drawn from the figures here given will not agree with the figures shown in the larger table, which figures have, in all cases, been corrected to June 30, 1919.

Project statements approved and project agreements executed, by States.

State.	Number of projects.		Total estimated cost.			Federal aid requested.			Mileage covered.		
	Prior to June 30, 1918.	Fiscal year 1919.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.
Alabama.....	26	25	\$506,583.67	\$1,243,338.37	\$1,839,922.04	\$295,976.59	\$616,371.86	\$912,348.45	174,295	137,222	311,517
Arizona.....	3	5	252,523.63	639,948.81	862,472.44	126,249.89	315,622.82	441,872.71	55,560	37,531	93,391
Arkansas.....	18	4	541,410.19	278,005.34	819,415.53	277,976.98	96,063.56	314,070.54	86,403	36,952	123,555
California.....	6	10	1,163,322.27	2,390,168.79	3,543,491.06	545,156.13	1,190,084.38	1,735,240.51	89,790	110,290	200,080
Colorado.....	8	5	559,268.70	1,033,486.31	752,758.01	279,634.34	96,744.66	376,379.00	160,510	48,435	208,945
Connecticut.....	1	3	148,694.04	1,486,145.51	1,634,839.55	53,000.00	737,200.00	790,230.00	5,300	51,083	56,383
Delaware.....	2	3	918,599.00	674,251.00	1,532,850.00	33,000.00	239,603.78	272,603.78	17,800	14,360	32,160
Florida.....	4	12	267,736.55	670,014.80	4,986,681.30	119,079.00	323,623.80	442,702.80	17,800	99,718	117,518
Georgia.....	14	60	773,578.75	4,213,102.55	4,986,681.30	362,756.34	1,940,464.05	2,304,220.39	201,840	403,091	606,931
Idaho.....	5	3	701,577.14	10,970,790.66	1,672,327.20	271,000.00	4,970,554.49	6,164,240.26	98,360	58,900	157,860
Illinois.....	3	6	2,532,714.42	4,331,318.80	5,128,748.80	302,900.00	2,144,211.00	2,446,511.00	30,230	101,850	132,080
Indiana.....	7	4	1,797,430.00	1,287,061.10	2,492,544.95	363,515.30	452,230.43	815,745.73	276,950	264,420	541,370
Iowa.....	16	21	2,205,483.85	5,462,843.96	8,030,956.72	393,670.22	1,119,584.15	1,513,254.37	131,475	158,430	289,905
Kansas.....	9	16	2,588,112.76	5,985,514.90	1,124,815.61	232,988.59	303,075.21	536,073.80	44,625	70,060	114,685
Kentucky.....	5	8	581,366.08	1,011,103.27	1,592,469.35	219,088.06	457,828.37	707,516.43	95,610	121,320	216,930
Louisiana.....	7	15	528,935.14	83,347.76	612,282.90	264,467.57	612,873.87	306,141.44	28,450	7,010	35,460
Maine.....	3	3	132,541.22	4,417,820.09	4,550,361.31	60,454.06	2,139,986.31	2,200,440.37	6,340	175,070	181,410
Massachusetts.....	8	8	532,393.73	938,100.22	1,470,493.95	224,308.38	665,042.70	1,454,877.18	161,725	97,728	51,665
Michigan.....	20	10	1,669,982.45	1,483,883.31	3,153,875.76	749,834.48	730,778.21	1,417,825.79	572,105	121,805	233,450
Minnesota.....	27	15	1,688,592.85	1,613,859.41	3,302,452.58	687,047.58	123,901.90	459,292.77	242,210	13,080	699,310
Mississippi.....	26	4	804,727.99	231,861.23	1,036,588.62	335,390.87	784,606.46	897,719.86	56,230	143,560	202,720
Missouri.....	6	13	383,465.23	2,026,106.66	2,409,571.89	113,113.40	63,777.56	515,407.68	60,250	98,120	208,460
Montana.....	7	32	127,555.12	903,350.31	1,030,953.43	309,763.70	1,121,443.30	1,431,207.00	341,970	148,120	323,070
Nebraska.....	10	4	753,982.30	2,281,419.78	3,035,402.08	252,278.47	408,172.68	720,451.15	92,300	150,783	243,083
Nevada.....	8	15	263,256.03	612,242.24	875,498.27	132,127.99	365,621.08	437,749.07	24,100	48,147	72,247
New Hampshire.....	16	30	257,341.26	1,540,779.05	1,798,120.31	59,212.68	305,080.00	424,242.68	9,694	32,091	41,785
New Jersey.....	12	5	908,293.44	4,222,391.74	1,330,685.18	454,144.21	211,198.37	665,312.58	296,320	58,550	294,570
New Mexico.....	12	5	716,174.11	3,104,633.97	3,890,807.85	358,087.05	1,575,566.87	1,933,653.92	41,350	116,940	158,290
New York.....	21	29	601,808.50	1,341,822.94	2,001,196.41	201,196.41	4,076,632.86	6,066,849.27	179,282	157,754	337,030
North Carolina.....	8	40	420,671.92	4,992,135.21	912,804.56	223,135.65	223,135.65	433,505.86	324,170	286,991	648,940
North Dakota.....	23	19	3,249,167.94	9,920,402.89	13,169,570.81	889,678.30	3,085,270.00	3,975,505.86	98,750	296,991	385,741
Ohio.....	17	53	375,131.55	1,228,238.29	1,603,369.84	147,229.37	584,101.52	731,330.89	30,092	62,368	92,460
Oklahoma.....	4	7									

Project statements approved.

Project statements approved and project agreements executed, by States—Continued.

Project statements approved.

State.	Number of projects.		Total estimated cost.			Federal aid requested.			Mileage covered.		
	Prior to June 30, 1918.	Fiscal year 1919.	Total to date.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.	Fiscal year 1919.	To June 30, 1919.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.
Oregon.....	7	9	16	\$861,814.94	\$916,247.88	\$1,870,062.82	\$420,585.61	\$850,951.58	98,520	79,770	178,290
Pennsylvania.....	16	27	43	3,812,824.80	9,026,044.21	12,838,869.01	1,181,130.00	4,947,183.99	118,113	202,880	320,995
Rhode Island.....	2	2	4	126,362.51	269,972.72	396,335.23	46,497.13	3,766,063.99	4,790	7,040	11,830
South Carolina.....	6	15	21	322,827.23	627,050.02	949,877.25	140,001.99	109,003.26	30,570	112,678	143,248
South Dakota.....	7	7	14	249,621.17	518,417.17	768,038.34	114,805.19	262,528.60	60,270	121,660	181,930
Tennessee.....	4	3	7	275,267.64	471,071.46	746,339.10	134,129.29	247,406.39	28,400	39,611	68,011
Texas.....	68	11	79	3,993,884.06	743,116.60	4,737,000.66	1,703,239.35	371,277.17	990,282	76,736	1,067,018
Utah.....	7	3	10	447,651.85	772,013.27	1,219,665.12	223,825.91	609,832.54	237,490	89,150	326,640
Vermont.....	9	1	10	131,678.45	37,468.74	169,147.19	65,839.21	84,573.53	12,705	4,155	16,860
Virginia.....	10	30	40	408,018.91	1,900,006.68	2,308,025.59	187,344.32	1,133,083.84	31,376	164,358	195,734
Washington.....	11	21	32	831,476.41	2,616,837.04	3,448,313.45	389,723.82	945,742.52	68,860	128,016	196,876
West Virginia.....	20	25	45	802,033.36	1,537,428.41	2,339,461.77	202,951.71	1,632,766.25	56,990	77,222	134,212
Wisconsin.....	43	45	88	1,431,412.65	1,788,070.38	3,269,483.03	493,804.17	810,437.28	195,343	215,815	411,158
Wyoming.....	15	9	24	365,618.23	757,829.55	1,123,447.78	182,809.10	1,088,849.84	143,270	110,530	253,800
Total.....	580	736	1,316	42,278,770.38	91,495,797.99	133,774,568.37	16,049,821.74	54,714,219.15	6,249,396	6,470,583	12,719,979

Project agreements executed.

State.	Number of projects.		Estimated cost.			Federal aid granted.			Mileage.		
	To June 30, 1918.	To June 30, 1919.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.
Alabama.....	23	10	\$529,007.68	\$381,219.15	\$910,226.83	\$263,507.11	\$191,606.23	\$455,113.34	148,145	72,392	221,537
Arizona.....	1	3	123,823.63	282,630.34	406,453.97	61,899.89	124,025.20	195,925.09	19,787	43,250	19,787
Arkansas.....	16	5	306,953.98	623,367.56	717,324.54	170,635.15	135,456.33	305,961.48	74,543	43,250	117,735
California.....	3	3	336,046.51	663,193.98	999,240.52	166,161.44	316,764.92	482,926.36	22,730	37,450	60,180
Colorado.....	1	2	239,631.19	404,322.06	644,003.25	119,340.59	232,161.02	322,601.61	80,140	40,014	120,154
Connecticut.....	1	2	148,694.04	256,145.23	404,830.27	53,000.00	128,072.61	181,072.61	5,300	7,830	13,130
Delaware.....	3	3	135,585.59	1,345,585.59	1,345,585.59	37,041.64	135,169.40	135,169.40	21,626	21,626	21,626
Florida.....	1	7	364,696.15	364,696.15	468,337.96	18,864.45	175,890.49	212,902.13	14,570	16,250	30,820
Georgia.....	1	27	37,728.90	1,904,390.34	1,942,119.24	18,864.45	883,477.91	302,342.36	72,033	253,581	307,614
Idaho.....	4	1	437,583.34	288,582.39	746,170.73	183,000.00	174,163.93	359,163.93	59,360	39,770	90,130
Illinois.....	1	9	1,815,663.84	1,815,663.84	1,815,663.84	183,000.00	811,746.69	811,746.69	65,357	65,357	65,357
Indiana.....	7	8	635,611.25	800,124.60	143,735.85	161,627.90	284,629.14	446,257.04	139,320	90,490	229,810
Iowa.....	7	7	1,209,422.87	1,209,422.87	1,209,422.87	441,745.28	441,745.28	441,745.28	41,030	41,030	41,030
Kansas.....	2	3	339,006.47	408,518.27	747,534.74	139,351.47	231,234.96	370,536.43	19,421	19,139	38,500
Kentucky.....	6	12	531,079.96	625,073.63	1,156,153.59	190,688.06	314,907.11	514,595.17	58,310	104,838	163,148
Louisiana.....	1	1	282,666.91	384,504.31	1,067,171.22	141,933.46	142,706.54	284,040.00	28,404	28,404	28,404
Maine.....	3	10	1,039,563.01	1,039,563.01	1,067,104.23	60,454.06	511,256.51	571,710.57	6,340	46,667	53,007
Maryland.....	6	2	243,128.93	338,870.54	583,973.47	109,248.38	171,035.48	230,883.86	12,435	11,865	24,300
Massachusetts.....	7	22	902,174.36	2,084,161.82	2,986,336.18	428,079.56	1,009,730.23	1,437,829.79	89,823	102,035	191,538
Michigan.....	12	24	813,019.71	1,258,708.27	2,071,727.94	333,842.18	514,700.33	848,542.51	222,135	240,080	462,215
Minnesota.....	4	11	205,703.27	535,340.65	761,043.92	90,000.00	238,896.73	348,896.73	40,410	91,026	131,436
Mississippi.....	2	6	160,725.40	484,081.64	644,807.04	40,181.35	206,596.65	246,778.00	14,040	57,820	71,860
Missouri.....	4	4	73,390.72	73,390.72	73,390.72	36,695.35	36,695.35	36,695.35	21,210	21,210	21,210
Montana.....	6	13	546,040.37	1,126,307.84	1,672,348.21	205,732.74	579,838.89	785,631.63	212,940	354,400	558,340
Nebraska.....	14	14	994,196.52	994,196.52	994,196.52	497,099.74	497,099.74	497,099.74	123,120	123,120	123,120
Nevada.....	8	14	122,915.34	149,020.09	271,044.43	61,457.64	135,049.54	135,049.54	12,440	11,080	23,520
New Hampshire.....	1	4	257,341.26	570,369.53	927,170.79	59,212.68	256,666.28	315,878.96	9,694	15,338	25,032
New Jersey.....	3	5	209,348.56	461,058.66	670,407.22	1,046,674.27	230,529.32	335,203.59	40,020	62,845	102,865
New Mexico.....	6	3	513,374.11	1,260,582.24	1,782,956.35	256,687.05	628,041.12	884,728.17	26,080	19,060	45,140
New York.....	12	5	433,919.25	1,046,867.52	1,480,786.77	135,696.41	345,255.84	480,928.25	90,132	119,383	204,515
North Carolina.....	6	27	162,235.77	525,901.95	688,137.72	81,117.88	262,920.94	344,068.92	92,240	241,810	334,050
North Dakota.....	8	14	1,229,580.28	3,058,157.68	4,287,737.96	382,073.00	362,039.17	327,993.36	39,000	47,420	136,420
Ohio.....	7	19	394,643.70	752,866.43	783,755.61	180,000.00	182,035.05	382,035.05	18,000	46,790	46,790
Oklahoma.....	1	6	1,053,222.47	5,774,001.91	7,429,224.46	512,820.00	2,701,064.53	3,214,454.53	40,469	136,973	177,442
Oregon.....	11	23	85,441.16	220,443.38	305,884.54	113,173.16	113,173.16	148,170.29	3,040	8,190	11,830
Pennsylvania.....	1	3	337,584.05	337,584.05	442,479.13	49,536.66	165,471.63	206,908.29	22,800	32,880	55,680
Rhode Island.....	3	7	85,595.08	85,595.08	85,595.08	49,536.66	165,471.63	206,908.29	22,800	32,880	55,680
South Carolina.....	1	3	85,595.08	85,595.08	85,595.08	49,536.66	165,471.63	206,908.29	22,800	32,880	55,680

Project agreements executed—Continued.

State.	Number of projects.			Estimated cost.			Federal aid granted.			Mileage.		
	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.	To June 30, 1918.	Fiscal year 1919.	To June 30, 1919.
South Dakota.....	4	5	\$170,625.55	\$134,129.29	\$85,312.76	\$85,312.76	28,400	49,910	49,910	49,910	49,910	49,910
Tennessee.....	4	3	779,709.90	140,405.14	252,221.12	386,350.41	49,949	39,381	67,781	520,126	520,126	520,126
Texas.....	6	40	2,628,462.92	65,566.05	979,868.83	1,120,273.97	44,890	470,177	113,070	113,070	113,070	113,070
Utah.....	1	3	472,062.17	30,650.13	170,465.03	236,081.08	4,355	8,830	13,185	13,185	13,185	13,185
Vermont.....	1	3	206,283.19	113,067.39	72,491.44	103,141.57	27,867	86,747	114,614	114,614	114,614	114,614
Virginia.....	7	17	1,194,651.92	212,223.82	470,462.62	583,530.01	39,880	30,233	70,113	70,113	70,113	70,113
Washington.....	7	7	940,997.03	54,891.48	229,287.56	441,511.38	9,370	40,005	49,375	49,375	49,375	49,375
West Virginia.....	5	18	896,555.93	168,787.36	320,658.50	375,549.98	48,257	217,258	263,515	263,515	263,515	263,515
Wisconsin.....	1	46	2,285,682.10	128,462.81	579,114.81	747,902.17	53,500	22,530	76,030	76,030	76,030	76,030
Wyoming.....	4	3	522,899.71	5,833,175.62	132,151.43	260,614.24	2,022,382	3,767,487	5,789,869	5,789,869	5,789,869	5,789,869
Total.....	224	453	56,418,763.07	5,833,175.62	18,048,441.97	23,931,617.59	2,022,382	3,767,487	5,789,869	5,789,869	5,789,869	5,789,869

Type of construction.

State.	1917.					
	Total number of projects 1917.	Bituminous concrete.		Brick.		Undetermined.
		Number.	Miles.	Number.	Miles.	
California.....	2	2	6.790			
Pennsylvania.....	3	3		1	2.675	12.714
Total.....	5	2	6.790	1	2.675	12.714

1918.

State.	Total number of projects 1918.	Earth.		Sand clay.		Gravel.		Macadam.		Macadam mat top.		Bituminous macadam.		Bituminous concrete.		Concrete.		Brick.		Miscellaneous.		Undetermined.	
		Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.
Alabama.....	22			12	96.295	7	35.180	1	9.170			2	8.500										
Arizona.....																							
Arkansas.....	16					10	48.384	3	9.540	1	8.080	1	2.990	1	5.549								
California.....	1		15.940																				
Colorado.....	4	1	8.940													3.950				3.130	1	64.120	
Connecticut.....	1															1	5.300			1			
Delaware.....																							
Florida.....	2			1	10.450																		
Georgia.....	1		72.033	1																			
Idaho.....	3	3	54.360			1	5.000																
Illinois.....																							
Indiana.....																							
Iowa.....	7	4	104.080			2	30.170									2	5.070						
Kansas.....																							
Kentucky.....	2	1	10.191					2	5.340										1	3.890			
Louisiana.....	5	1	5.360			4	48.950							1	4.000								
Maine.....	3																						
Massachusetts.....	6							1	3.240			3	28.404										
Maryland.....	3											2	2.487	2	4.526	1	2.182						
																3	6.340						

Type of construction—Continued.

1918.

State.	Total number of projects 1918.	Earth.		Sand clay.		Gravel.		Macadam.		Macadam mat top.		Bituminous macadam.		Bituminous concrete.		Concrete.		Brick.		Miscellaneous.		Undetermined.		
		Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.		
Michigan.....	7	1	46.820			2	22.105			1	5.983			1	2.000	3	12.915							
Minnesota.....	11	2	40.210			9	181.925																	
Mississippi.....	4					4	40.410									1	7.500							
Missouri.....	2					1	6.510																	
Montana.....																								
Nebraska.....	6	4	167.890	4	7.410	1	15.100											1	5.440			1	17.100	
Nevada.....																								
New Hampshire.....	8					4	8.440							3	2.740							1	1.260	
New Jersey.....	1																					1	9.694	
New Mexico.....	3					3	40.020																	
New York.....	6																							
North Carolina.....	11	3	18.290	2	16.240	2	16.240		1	11.440	1	1.060	2	6.070			2	7.510					1	1.260
North Dakota.....	8	5	68.770			4	23.470										1	1.782					1	9.694
Ohio.....	7																1	3.730	3	9.445			3	37.580
Oklahoma.....																								
Oregon.....	1																							
Pennsylvania.....	5													1	18.000									
Rhode Island.....	1													1	7.450	3	13.444	1	4.186					
South Carolina.....	3													1	3.640									
South Dakota.....						2	16.010							1	2.840	2	3.950							
Tennessee.....	4																							
Texas.....	6								3	26.550						1	1.870							
Utah.....	1								3	39.889						2	5.155			1	4.905			
Vermont.....	1																							
Virginia.....	4					4	4.355																	
Washington.....	7																							
West Virginia.....	7	1	5.220	1	8.033	3	3.510	3	8.874							1	3.070					1	4.380	
Wisconsin.....	5					5	31.160									1	3.500							
Wyoming.....	14	1	6.290			3	13.360	4	14.647					1	2.530	3	4.830	1	2.010					
Wyoing.....	4	4	43.750			1	4.750									6	13.960							
Total.....	212	32	596.111	23	226.471	68	579.069	18	88.781	6	55.012	10	48.451	13	53.275	36	111.058	8	29.091	2	8.035	12	204.849	

Type of construction—Continued.

1919

State.	Total number of projects 1919.		Earth.		Sand clay.		Gravel.		Macadam.		Macadam mat top.		Bituminous macadam.		Bituminous concrete.		Concrete.		Brick.		Miscellaneous.		Undetermined.	
	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	Miles.	Number.	
Pennsylvania.....	24																							
Rhode Island.....	3																							
South Carolina.....	6	3,530	3	25,090		2,140																		
South Dakota.....	5	23,640			3	28,270																		
Tennessee.....	3					15,392																		
Texas.....	40	21,140	2	26,280	14	165,692																		
Utah.....	3	58,900																						
Vermont.....	3																							
Virginia.....	16	6,750	3	18,314		8,880																		
Washington.....	6					10,982																		
West Virginia.....	18	4,000			5	26,707																		
Wisconsin.....	46	66,346	1	5,750	9	39,760																		
Wyoming.....	3	10,410			1	4,120																		
Total.....	445	1,026,409	45	400,234	119	1,022,675	16	86,171	15	115,066	17	77,753	12	58,105	102	467,827	9	35,062	3	29,756	39	447,429		

NOTE.—The differences between the number of projects shown on this report and on the report of project agreements executed is due (1) to the omission of projects covering the erection of bridges only and (2) to the counting of projects twice where they contain two types of construction.

NATIONAL FOREST ROADS.

During the first half of the fiscal year unfavorable conditions for road improvement, resulting from the war, limited the period during which active operations have been resumed to a few months of the present construction season. The major portion of the work for this fiscal year has been in the last four months. There has been in these few months a marked increase in road activities in the national forests, even though conditions have not returned to the normal pre-war basis.

The year has been marked with a shortage of labor, equipment, and material for construction purposes. Unsettled conditions generally have made contractors extremely cautious, and it has often been difficult to recommend to you awards for work at what was considered satisfactory prices. On a number of occasions we have felt it advisable to recommend against making awards even after work had been extensively advertised and previous proposals rejected. In these instances department forces have been organized to start the work and other portions of the projects have been let out to station contractors. A great handicap to the work has been the lack of suitable equipment in the possession of local contractors who are making proposals on road construction. The assembling at points convenient to our operations of suitable construction equipment which can be loaned to contractors for our work will aid materially in securing more reasonable prices and hasten the completion of our building program.

It is hoped that from the surplus equipment of the War Department allotted to this bureau under the terms of section 7 of the Post Office appropriation act it will be possible to provide for the major equipment needs of this bureau. Requisition has been placed and shipping orders given for approximately \$2,000,000 worth of equipment and material. Very little has been received in time for this season's work. It is important that it be secured in ample time for proper assembling, overhauling, and distribution before the next construction season opens, so that the purchase of other equipment may be obviated.

With respect to explosives the bureau has been materially benefited in having allotted to it about 4,000,000 pounds of T. N. T. from the War and Interior Departments. Considerable of this material has been delivered and some has been used on our work during the present season.

The general organization plan followed during the preceding fiscal year has been continued, there being six distinct offices and suboffices to cooperate with the six western forest districts, the work in the seventh forest district being divided among the district engineers of this bureau in charge of post road work. There has been an increase in the personnel on forest-road work made necessary by our increased building program.

The following tabulation is a summary of forest-road activities for the fiscal year ending June 30, 1919:

National forest road activities during fiscal year ended June 30, 1919.

State.	Engineering, investigation, and reconstruction surveys completed.			Cooperative agreements executed.				
	Number.	Miles.	Estimated cost of construction.	Number.	Miles.	Total amount.	Federal.	Local.
Alaska.....	9	204	\$1,223,080	10	190	\$1,019,695	\$488,558	\$531,137
Arizona.....	5	94	444,856					
Arkansas.....	10	294	1,381,062	7	107	595,900	299,950	296,050
California.....	10	237	1,077,450	9	194	700,833	517,785	183,048
Florida.....				1	27	90,000	43,000	47,000
Georgia.....	1	18	82,247					
Idaho.....	3	54	877,062	6	189	389,840	205,295	184,545
Minnesota.....				1	31	150,000	90,000	60,000
Montana.....	2	18	70,714	7	36	911,140	51,070	40,070
North Carolina.....	4	65	525,923					
Nevada.....	1	6	28,144	1	19	45,000	22,500	22,500
New Mexico.....	2	16	42,500	5	73	331,119	238,619	92,500
Oregon.....	3	119	1,037,232	12	238	1,541,550	729,675	812,475
South Dakota.....	1	31	104,400	3	60	78,400	63,200	42,200
Tennessee.....	5	73	570,112					
Utah.....	1	19	50,050	7	224	593,290	296,645	296,645
Virginia.....								
Washington.....	4	85	1,758,635	6	42	717,692	372,435	345,257
Wyoming.....	2	21	83,500	6	180	581,600	368,300	213,300
Total.....	63	1,354	9,356,967	81	1,610	7,746,059	3,786,432	3,166,727

State.	Location surveys.					
	In progress.			Completed.		
	Number.	Miles.	Estimated cost of construction.	Number.	Miles.	Estimated cost of construction.
Alaska.....	2	11	\$77,000			
Arizona.....	4	87	385,000	1	7	\$53,486
Arkansas.....	1	10	56,927			
California.....	5	77	658,500	5	84	1,377,000
Colorado.....				1	13	54,700
Florida.....				1	27	70,838
Georgia.....						
Idaho.....	2	65	353,524	1	23	175,303
Minnesota.....						
Montana.....	2	34	234,880	4	45	224,248
North Carolina.....				1	10	86,480
Nevada.....						
New Mexico.....				5	112	405,818
Oregon.....	2	42	471,503	4	23	447,727
South Dakota.....	1	31	104,400			
Tennessee.....						
Utah.....				2	74	209,950
Virginia.....	1	10	96,000			
Washington.....	1	11	109,260	2	29	502,552
Wyoming.....				1	69	325,000
Total.....	21	378	2,546,994	28	516	3,933,102

National forest road activities during fiscal year ended June 30, 1919—Contd.

State.	Plans.					
	In progress.			Completed.		
	Number.	Miles.	Estimated cost of construction.	Number.	Miles.	Estimated cost of construction.
Alaska.....						
Arizona.....	4	73	\$335,000	2	101	\$599,995
Arkansas.....						
California.....	5	62	867,000	3	16	186,437
Colorado.....	1	13	54,700	3	87	728,110
Florida.....				1	27	70,838
Georgia.....						
Idaho.....	2	65	353,524	1	23	175,303
Minnesota.....						
Montana.....	3	42	279,842	4	45	224,248
North Carolina.....	1	10	86,480			
Nevada.....						
New Mexico.....	1	31	66,000	4	81	339,818
Oregon.....	7	106	1,383,283	3	38	390,991
South Dakota.....	1	31	104,400			
Tennessee.....	1	12	107,561			
Utah.....	2	74	210,000	6	223	437,000
Virginia.....	1	10	96,000			
Washington.....	5	46	907,656	1	2	35,000
Wyoming.....				2	138	575,000
Total.....	34	575	4,851,446	30	781	3,762,740

State.	Construction.					
	In progress.			Completed.		
	Number.	Miles.	Estimated cost of construction.	Number.	Miles.	Estimated cost of construction.
Alaska.....	3	14	\$93,000			
Arizona.....						
Arkansas.....	1	31	72,655			
California.....	5	34	456,231	1	59	\$73,291
Colorado.....	3	89	542,148			
Florida.....	1	27	9,000			
Georgia.....						
Idaho.....	3	38	337,067			
Minnesota.....						
Montana.....	8	81	349,116	1	4	62,025
North Carolina.....						
Nevada.....						
New Mexico.....				1	4	20,000
Oregon.....	6	45	757,242			
South Dakota.....						
Tennessee.....						
Utah.....	5	204	387,027			
Virginia.....						
Washington.....	4	18	328,757			
Wyoming.....						
Total.....	39	581	3,332,243	3	67	155,316

DISTRIBUTION OF SURPLUS WAR EQUIPMENT, SUPPLIES, AND MATERIALS.

As a further stimulus to road-building activities and to facilitate the resumption of such work by the several State highway departments, Congress also incorporated in the Post Office appropriation act of February 28, 1919, a provision authorizing the Secretary of War to turn over to the Secretary of Agriculture for distribution

to the States available war material, equipment, and supplies suitable for use in the improvement of highways and not needed for the purposes of the War Department, to be used on roads constructed in whole or in part by Federal aid, the Secretary of Agriculture being authorized to retain from such distribution not to exceed 10 per cent of such material, equipment, and supplies for use in the construction of national forest roads or other roads constructed under his direct supervision. Such materials were required to be distributed to the States on the same basis as provided by the Federal aid road act for the apportionment of the Federal aid appropriations. Immediately on receipt from the War Department of lists of materials, equipment, and supplies declared to be surplus, a canvass was made to ascertain the requirements of the several States, and allotments were made with a view to meeting these requirements. There had been allotted to the States 20,519 motor trucks and quite a number of miscellaneous articles of equipment suitable for road-building purposes. There was in the hands of the War Department in the United States and in France quite a large amount of additional surplus equipment suitable for use in road-construction work, and the War Department signified that much of this would be turned over to this department.

At the close of the fiscal year about one-third of the number of motor vehicles allotted were actually in possession of the States, and only a very small list of other equipment, supplies, or materials were actually delivered. The total number of motor vehicles and amounts of other equipment and supplies that will eventually be made available for use by the States can not be stated. This distribution of trucks, although not proceeding as rapidly as had been hoped, has assisted many of the States greatly in resuming their road programs. This bureau has acted only as an agent of distribution between the War Department and the various State highway departments, but it is believed that the policy of making available surplus materials and equipment which could be directly used for road-building purposes is one from which the public generally is likely to receive a far greater benefit than if such supplies were disposed of through sales to private concerns. The faith in such a policy has resulted in a vigorous and persistent effort to secure for the States as large an amount of the equipment and supplies as can be put into useful service within a reasonable length of time. This policy has extended to the dispatching of a special representative to France to receive consignments of such material available in France for return to this country.

ROAD BUILDING AND MAINTENANCE INVESTIGATION.

An object-lesson road was built of sand-clay construction in Pierce County, Ga.

Reports on county road systems were made by Butte, Colusa, Santa Cruz, Solano, Sonoma, Sutter, and Yolo Counties, Calif. Advice was given regarding special road problems in Massachusetts, North Carolina, South Carolina, and Virginia. Engineers were furnished to plan and superintend the construction of the Alexandria-Camp Humphreys road in Virginia.

Designs for bridges were prepared as follows: Alabama, 1; Kansas, 1; Virginia, 1.

Engineers were assigned to investigate existing bridges and conditions in relation to proposed bridges as follows: Connecticut, 1; Georgia, 1; North Carolina, 2; New Jersey, 1; South Carolina, 2; Virginia, 1; West Virginia, 6.

In addition to the above general designs were prepared and those prepared by State and other officials have been reviewed.

FIELD EXPERIMENTS.

Approximately 26 miles of experimental roads which had been constructed during previous years in Alexandria and Fairfax Counties, Va., in Montgomery County, Md., and in the Department of Agriculture grounds were maintained.

MODELS AND EXHIBITS.

Practical demonstrations by means of models and other exhibit materials were made during the year to illustrate the various activities of the bureau. This exhibit material was built and maintained by the bureau, but all expenses of transportation and installation were paid by the organizations benefited.

All exhibit work was carried on under the supervision of the Office of Exhibits of the department which cooperated with other departments in placing a combined Government exhibit on display at the following locations:

Sedalia, Mo.....	Aug. 10-17	Berlin, Conn.....	Sept. 24-28
Springfield, Ill.....	Aug. 9-24	Memphis, Tenn.....	Sept. 21-28
Des Moines, Iowa.....	Aug. 21-30	Hutchinson, Kans.....	Sept. 16-21
Erie, Pa.....	Aug. 19-24	Pueblo, Colo.....	Sept. 23-28
Columbus, Ohio.....	Aug. 26-31	Salt Lake City, Utah.....	Sept. 30-Oct. 5
Detroit, Mich.....	Aug. 30-Sept. 8	Wichita, Kans.....	Sept. 30-Oct. 12
Homlin, Minn.....	Sept. 2-7	Muskogee, Okla.....	Sept. 30-Oct. 5
Rochester, N. Y.....	Sept. 2-7	Trenton, N. J.....	Sept. 30-Oct. 4
Indianapolis, Ind.....	Sept. 3-7	Knoxville, Tenn.....	Oct. 7-12
Lincoln, Nebr.....	Sept. 1-6	Atlanta, Ga.....	Oct. 14-19
Milwaukee, Wis.....	Sept. 9-14	Kansas City, Mo.....	Oct. 16-26
Syracuse, N. Y.....	Sept. 9-14	Los Angeles, Calif.....	Oct. 12-26
Nashville, Tenn.....	Sept. 16-21	Macon, Ga.....	Oct. 30-Nov. 9
Topeka, Kans.....	Sept. 9-14	Waco, Tex.....	Nov. 2-17
Douglas, Wyo.....	Sept. 10-14	Valdosta, Ga.....	Nov. 18-23
Huron, S. Dak.....	Sept. 9-14	Jacksonville, Fla.....	Nov. 27-Dec. 6
Lemmon, S. Dak.....	Sept. 18-20	Baltimore, Md.....	Dec. 8-15
Oklahoma City, Okla.....	Sept. 21-28		

In addition thereto a full set of road models was loaned to the commanding officer, Camp A. A. Humphreys during the month of July, 1919, for use in the Engineer School of the United States Army.

ADDRESSES, LECTURES, AND PAPERS.

The practice of rendering technical advice through the medium of conferences, lectures, and the presentation of papers at public gatherings was somewhat curtailed during the year on account of the war. Representatives were assigned to attend only those meetings and conferences of official bodies which were of State or Nation-wide importance. A total of 68 lectures were delivered, as compared with 149 during 1918.

PHOTOGRAPHIC WORK.

There were developed in the photographic laboratory 2,254 negatives, 14,584 prints were made, 771 lantern slides, 249 bromide enlargements, and 1,893 photostat prints.

In addition to this work, 868 lantern slides were colored for lecture work and 240 maps were mounted on cloth.

For the benefit of various individuals and organizations, including employees of the office, 2,716 lantern slides, 11,746 prints, and 206 bromide enlargements were loaned. At the close of the year the photographic files contained 18,951 negatives, 64,041 prints, and 10,614 lantern slides.

ROAD MANAGEMENT AND ECONOMICS.

The economic highway survey inaugurated toward the end of the fiscal year ended June 30, 1917, has been continued, but on a lesser scale than during the fiscal year 1918. This condition was brought about by the participation of this bureau to a large extent in activities connected with war work, and later to the added stimulus given road construction by the increased appropriations made by Congress for Federal aid work. The office work of completing the final maps of the area surveyed has been in progress during the year. The complete maps and text give detailed information on the roads, bridges, and economic conditions in the territory covered by the surveys. This work has proved of considerable value, as it brings together in a workable manner a vast amount of detailed highway information. The work has not only been of value to the State highway departments and this bureau, but is proving of value to other branches of the Government.

A large amount of data has been compiled relative to the tonnage of the products of the field, forest, and mine for the various counties in the United States. This information finally tabulated will be of considerable value in connection with the future planning of main-line highways, and will also govern to a considerable extent the types of pavement to be constructed on these highways.

ECONOMIC STUDIES OF HIGHWAY SYSTEMS.

The study carried out during the preceding year of the classification of highways and of the procedure followed in their construction and maintenance has been completed, and the final results have been published in serial form in *Public Roads Magazine* under the caption, "State Highway Management, Control, and Procedure." These articles are found in the issues, July, 1918, to February, 1919, inclusive.

FARM IRRIGATION INVESTIGATIONS.

Conclusion of the war terminated the many special investigations which had been made in behalf of the Capital Issues Committee regarding the feasibility and desirability of irrigation and drainage enterprises in course of promotion. Demands for this work were promptly succeeded, however, by calls for advice and technical assistance from many irrigation and drainage districts, organized

or prospective, whose plans, held in abeyance during the war, sought immediate execution at its close. Irrigation enterprises of this class, including in all many hundreds of thousands of acres, comprised besides new projects several of long and fairly prosperous history. High values of farm produce gave much encouragement to such enterprises to improve their structure, revise their organizations, and conserve their water supplies, to the end that a more economical distribution of water might be effected and the area served in the past materially extended. Thus, in Idaho alone, projects are now in various stages of promotion which, if carried out as now planned, will increase the irrigated area of the State by 1,500,000 acres; half as much as is now irrigated.

Notwithstanding the rapid development of this work, standard investigations of duty of water, pumping, flow of water in various types of conduits, and efficiency of appliances and equipment used in irrigation, which had either been temporarily discontinued or reduced in scope during the war, were resumed. Technical reports on flow of water in concrete pipes and spillways for reservoirs and canals were completed and await publication. An extensive field examination to determine the efficiency of typical reservoirs in Cache la Poudre Valley, Colo., begun in 1917, was brought to a conclusion. Meanwhile the investigation of flow of water was extended to metal pipes, a survey of effective types of chutes, drops, and other canal structures, begun prior to the war, was resumed, and a final report was prepared on three-years' experiments to determine the proper time and amount of irrigations in the vicinity of Twin Falls, Idaho. Laboratory experiments, which sought to ascertain the movement of moisture from a free-water surface in various soils, were finished and the results assembled in a report which awaits publication. Studies of the capillary movement of moisture between soils of different moisture content were resumed. These investigations are being supplemented by similar studies in irrigated fields, lands provided with artificial drainage, and soils which should be drained.

High cost of iron and steel has greatly widened the field and enlarged the demand for concrete pipe to meet rigid conditions in irrigation systems, notably where pressure pipe is needed for the conveyance of water under high heads. California alone now has more than 150 concrete pipe manufacturers, and concrete pipe is being installed at the rate of many hundred miles a year. A need for the standardization of methods of manufacture and the development of standard tests and testing equipment to determine the strengths of pipes of different makes has resulted in the establishment of a field laboratory where such equipment will be devised and tests conducted. Field tests, meanwhile, have been made to determine the tensile strength, resistance to internal pressure, and perviousness of 40 kinds of concrete pipe now in use in irrigation.

Other work demanded by after-war conditions has included a study of new devices to reduce labor in the distribution and application of water, initiation of experiments to determine the extent of seepage losses from canals, and the extending of first-hand assistance to communities seeking the development of underground water for irrigation. High prices and curtailment of sales of pumping

machinery during the war resulted in a material lessening of interest in pumping, but conditions of severe drought and a lifting of war restrictions immediately restored pumping to a position of prime importance in the irrigation field.

DRAINAGE INVESTIGATIONS.

Until the close of the calendar year war conditions continued largely to control the operations of the division. In addition to the fact that approximately 50 per cent of the force was in the military service, the immediate requirements of the situation diverted the attention of agricultural landowners temporarily from contemplated drainage work. Early in 1919, when the improvement of their land once more claimed their attention, the landowners were at once confronted by the prevailing high costs of labor and materials. Nevertheless a decided tendency has been shown to proceed with important drainage projects in spite of high costs. This tendency has been so marked that by the close of the fiscal year the activities of the drainage division were limited only by the funds available.

Operations, though curtailed, were carried along the same lines as in former years. More attention, however, was given to small projects such as those of farm drainage that would bring quick results, and less to the larger undertakings. Certain technical investigations which had been started in former years and which required continuous records to yield their greatest value were continued.

Cooperative working agreements with the States of Alabama, Arkansas, Georgia, North Carolina, and Tennessee were continued.

During the year 126 separate surveys, in 13 States, were made, and drainage plans prepared for farms where the owner desired either to install tile or construct terraces. In many other cases field examinations were made and advice given informally. The manuscript for a bulletin on farm drainage, to be published by the West Virginia College of Agriculture, was prepared, as was also one for publication by the Alabama Agricultural Experiment Station.

A report on drainage conditions in Michigan was prepared after a full investigation of all aspects of the situation in that State. This report was prepared in cooperation with, and published by, the Michigan Geological and Biological Survey. Studies of the cost of operation of drainage pumping plants in southern Louisiana were continued. The study of the matter of drainage assessments was resumed after having been suspended during the war.

A comprehensive study of the drainage problem presented by the Red River of the North has been undertaken. This work consisted mainly in the correlation of existing data, and has for its ultimate object the correction of the overflow and permanently wet conditions of extensive tracts of land along the river in Minnesota, North Dakota, and South Dakota. Twenty-seven preliminary examinations were made of overflowing streams and swamp areas in various States and reports submitted to landowners.

Studies of underground water and the subsidence of muck soils after draining were made in Florida. Investigations of methods

of draining muck and peat soils were carried on in the State of New York.

The records of rainfall and run-off which have been kept continuously since 1910 in the prairie section of Louisiana have been continued. These records are of great value, as they determine the percentage of the rainfall that must be removed, and therefore establish the required capacity of drainage plants. The manuscript was prepared for a bulletin which will summarize the experiments made by this division for determining the roughness coefficient in Kutter's formula. These experiments were made in dredged ditches in Mississippi, Tennessee, Iowa, North Carolina, and Florida. The manuscript for a bulletin giving the results of an extensive study of the flow of water in tile drains has also been completed.

In accordance with an agreement with the Florida Agricultural Experiment Station, cooperative experiments were conducted on the farm of the experiment station at Gainesville, for the purpose of determining the value of sewage irrigation for that type of soil. Experiments were conducted at Vineland, N. J., with several new types of spray nozzles and automatic irrigation sewage valves. Numerous plans for small irrigation plants in the humid section have been prepared and much assistance of an advisory nature rendered.

Twelve investigations and reports were made during the first half of the year, to the Capital Issues Committee, respecting projects for which bond issues were proposed.

RURAL ENGINEERING.

FARM DOMESTIC WATER SUPPLY AND SEWAGE DISPOSAL.

Seven field examinations were made of farm water systems, and advice was given for improving them.

Five rural septic tank installations were designed or the main features outlined.

Work was begun on the preparation of manuscript and illustrations for a bulletin on "Simple Sanitary Conveniences for Farm and Tenant Houses."

Estimate of cost and specifications were prepared for a gravity water system for a large farm establishment in Georgia.

Data was compiled relative to garbage disposal and reduction, plumbing systems, and sewer and pool cleaning machines.

FARM STRUCTURES.

There were prepared for general distribution working drawings, and, in most instances, bills of materials for the following farm structures: A granary, two rural schoolhouses, four farmhouses, three bunk houses, two milk houses, standard cow manger, dairy barn, poultry house, manure pit, roof and storm cellar, movable hog house, self-feeder for hogs, bull barn, breeding rack for cattle, and a small garage.

Plans were prepared for the plumbing and heating layout for the proposed laboratory building at Arlington for the Bureau of Public Roads.

For other bureaus of the department drawings for the following were prepared: Milk station, cheese factory and creamery for the

Bureau of Animal Industry, a garage and shed, a greenhouse, and a foreman's residence for the Bureau of Plant Industry at Sacaton, Ariz. This latter was designed particularly to meet conditions prevailing in the arid sections, and it undoubtedly will prove of assistance to ranchers and others in future building operations in Arizona and other arid sections.

An inspection was made of the offices of the Bureau of Crop Estimates, and inspection and advice given relative to the design and construction of a large manure pit at the United States Soldiers' Home. The construction of the Color Investigations Laboratory at Arlington was supervised for the Bureau of Chemistry.

The preparation of the manuscript for a bulletin on the Farm Shop and Equipment was begun.

A number of designs were prepared for use in a bulletin on cattle feeding to be published in cooperation with the Division of Animal Husbandry.

An illustrated yearbook article, "Housing the Worker on the Farm," was prepared and published as a separate.

A number of informal talks were given before demonstration agents in the South on rural housing.

The architect of the division was detailed from August 1, 1918, to April 1, 1919, to the Building Materials Division of the United States War Industries Board to assist in the preparation of standard specifications and details for building construction.

MECHANICAL PROBLEMS.

The dust-spraying apparatus for dusting cotton plants for boll weevil, designed during the previous year, was further developed in cooperation with the Bureau of Entomology.

For the purpose of obtaining data a number of private hydro-electric installations were inspected.

Drawings for several pieces of chemical apparatus were prepared for the Bureau of Chemistry, including an air-cooled gas reaction apparatus, laboratory gas reaction apparatus, metal baths, a phthalic anhydride plant, condensers, automatic valve control.

A yearbook article on "Electricity and power from small streams" was prepared and published as a separate.

Manuscripts and numerous drawings for illustrations for bulletins on "Farm House Heating Plants," "Farm House Lighting," and "Farm Hydro-Electric Plants" were started but the work was not completed.

Farmers' Bulletin No. 991, which is number five of the series "Care and Repair of Farm Implements," was prepared and published.

The chief of the division, assigned to the Secretary's committee on farm equipment control, did considerable work in this connection during the year. Upon the resignation in the spring of 1919 of the official in charge, all of that work was turned over to the Division of Rural Engineering and has been handled without any addition to funds or personnel of the division.

During the season of 1918 the United States Food Administration conducted a campaign looking to the conservation of grain through improved methods of grain thrashing. Upon the termination of the Food Administration's activities the grain saving work was taken

over by the Division of Rural Engineering in cooperation with the States Relations Service. In furtherance of the conservation work "thrasher schools" were held in various parts of the grain growing sections of the country. Engineers of the division outlined the courses for and attended these schools, giving talks and demonstrations to farmers and thrasher men on thrasher operating. Though the work was begun late in the spring the results were gratifying as it was shown that more good can be accomplished by instruction prior to the opening of the thrasher season than by an attempt at supervision of operations during thrashing.

MISCELLANEOUS.

In connection with replies to requests for assistance on rural engineering problems there were prepared sketches, data, and short articles on a variety of subjects. In the solution of specific problems there were prepared sketch drawings of alterations and additions to farmhouses, details of a concrete floor slab, sketch showing how to cut rafters, a four-horse eveners, a concrete seed and potato warehouse, farmhouse heating layouts, farmhouse lighting layouts, a hydropneumatic system for hard and soft water, farmstead layouts.

To the information series used in connection with the correspondence there was added information relating to the following subjects: Fireplace construction, farmstead planning, dairies, plaster and plastering, building materials (manufacturers and dealers).

Problems and correspondence relating to the following subjects have been handled:

Farm structures,
Wall plasters and kalsomines,
Ice house design and construction,
Farm water supply,
Farm sewage disposal,
Farm hydroelectric plants,
Farm lighting systems,
Painting,
Stump pullers,
Farm heating systems,
Windmill electric plants,
Grinding mills,
Thrasher boiler inspection,
Concrete construction,
Cooling systems,

Stream surveys and developments,
Farm ice houses,
Farmstead planning,
Chemical closets,
Farm implements,
Tractors and gas engines,
Protection against lightning,
Fencing,
Stone work,
Insulation,
Damp cellars,
Cement stucco,
Lumber,
Motors, and
Disinfectants.

Exhibits representing the work of the division were prepared for use on county fair circuits; one was also sent to France. Plans for farm structures were sent to France with a view to their use in connection with the reconstruction of the devastated sections of that country and for the instruction of members of the American Expeditionary Forces who are expecting to follow farming when they return to the United States.

TRACTION TESTS.

Calculation of results of traction tests made in the last few years were discontinued in December owing to the induction into military service of the man handling that work.

Under section 9 of "An act making appropriation for the service of the Post Office Department for the fiscal year ending June 30, 1920,

and for other purposes," the Secretary of Agriculture is required, through the War Department, to ascertain the number of days any soldier, sailor, or marine has worked on public roads in the several States (other than roads within the limits of cantonments or military reservations in the several States) during the war, the location of the work, and the names and rank of the men so employed. It is further authorized that any officer or enlisted man who has so worked shall have his pay equalized to conform to the compensation paid to civilian employees in the same or like employment, and the amount found to be due shall be paid from the 1920 appropriation allotted in section 8 of the same act to the States wherein the construction or repair work was performed.

As all work done as described in section 9, above referred to, was under the supervision of the War Department, and as the necessary fiscal arrangements require the certification of some supervisory official cognizant with the work, it was found desirable, to expedite the preparation of the necessary pay vouchers, to ask the Secretary of War to detail a representative of that department who should have cognizance of the work to act as such certifying officer. In response to this request the Secretary of War detailed a representative to act conjointly with a representative assigned from the Bureau of Public Roads of the Department of Agriculture, and the assembling of the required records and claims and the preparation of the necessary vouchers are now in progress.

ROAD MATERIAL TESTS AND RESEARCH.

During the first six months of the last fiscal year research work was continued as during the previous year in a much curtailed form. Inability to obtain men to replace those entering the Army, cooperation with other branches of the Government in war activities, and supervision of specifications and the materials used in Federal-aid road construction account for this lull in investigation work.

Up to November assistance was given the Fuel Administration in its work for the United States Highways Council. This consisted in making recommendations relative to granting permits for securing bituminous materials for road construction and maintenance. In November a plan of research was outlined in order to continue this class of work with renewed vigor, and from November to the end of the fiscal year this phase of laboratory activities has been greatly increased with a corresponding increase in personnel.

ROUTINE CHEMICAL TESTING AND INSPECTION.

Two hundred and sixty-three samples were examined in the chemical laboratory. This represents a decrease of 9 per cent as compared with the preceding fiscal year. Of the samples examined, 206 were bituminous materials, 46 metal, and 11 sand, rock, and Portland cement.

PHYSICAL TESTS OF ROAD BUILDING MATERIAL.

In the physical laboratory, 1,804 samples were tested. This is an increase of 7 per cent as compared with the preceding fiscal year, and is well above the average of routine work. The samples may

be classified as follows: Rock, 262; concrete, 252; sand, 205; gravel, 151; slag, 54; cement, 49; miscellaneous, 111. Samples were received from 41 States, and also from Canada. The geographical distribution of samples examined is as follows:

Alabama -----	26	Nevada -----	3
Arizona -----	8	New Hampshire -----	7
Arkansas -----	6	New Jersey -----	9
California -----	2	New York -----	7
Colorado -----	9	North Carolina -----	38
Connecticut -----	2	North Dakota -----	1
Delaware -----	15	Ohio -----	65
District of Columbia -----	47	Pennsylvania -----	39
Florida -----	39	South Carolina -----	15
Georgia -----	10	South Dakota -----	2
Idaho -----	2	Tennessee -----	17
Illinois -----	15	Texas -----	8
Indiana -----	2	Utah -----	14
Iowa -----	3	Virginia -----	489
Kentucky -----	6	Washington -----	1
Maine -----	9	West Virginia -----	41
Maryland -----	32	Wisconsin -----	6
Massachusetts -----	15	Canada -----	1
Michigan -----	14		
Minnesota -----	13	Total -----	1,081
Mississippi -----	17	Unclassified -----	3
Missouri -----	8		
Montana -----	13		1,084
Nebraska -----	7		

MICROSCOPIC EXAMINATION AND CLASSIFICATION OF ROAD-BUILDING ROCK.

The Petrographic Laboratory examined 686 samples of road-building material during the year, an increase of almost 9 per cent over the preceding year and well above the average of routine work. Of these samples, 249 were rock, 41 slag, 151 gravel, 189 sand, 45 clay, and 11 miscellaneous.

Of the samples examined in the physical, chemical, and petrographic laboratories, 355 were materials for use in Federal-aid construction.

RESEARCH ON DUST PREVENTIVES AND ROAD BINDERS.

The following investigations have been under way on bituminous materials:

1. Comparison of old and new volatilization tests in gas and electric ovens.
2. Exposure tests on bituminous materials of known chemical composition.
3. Study of the distillation of California and Mexican petroleum with reference to the manufacture of road oils.
4. Bituminous joint fillers.
5. Chemical composition of asphalts and tars.
6. Methods of making float tests.
7. Investigation of the action of copper salts on bituminous materials.
8. Investigation of the toughness of bituminous aggregates.

One investigation on the thickness of bituminous films on different types of aggregates has been completed and the data is ready to be worked up in form for publication. A study of the asphalt content of oils has also been completed and is ready to be put in shape for publication. A paper is now being published on the microscopic examination of bituminous materials. A paper on the Efficiency of Bituminous Surfaces and Bituminous Pavements under

Heavy Motor Truck Traffic was presented before the American Road Builders' Association.

EXPERIMENTAL BITUMINOUS ROAD CONSTRUCTION AND MAINTENANCE.

As during the previous year, supervision and inspection of experimental bituminous roads has been confined largely to the vicinity of Washington. One inspection was made, however, of the road between Boston, Mass., and Portland, Me., and between Portland and Bowdoinham, Mass.

NONBITUMINOUS ROAD MATERIAL INVESTIGATIONS.

The quarry investigations begun during the previous year to study industrial practice in the preparation of commercial broken stone aggregates with a view to standardization of sizes and to obtain cost data, etc., was continued and an extensive study was made of the quarries in the South and in eastern Massachusetts and of two quarries near Poughkeepsie, N. Y. Altogether 64 inspections were made of crushed stone producing plants. Papers written as a result of these investigations appeared in the September, 1918, and the June, 1918, issues of Public Roads.

A large number of brick roads were inspected throughout Ohio, Indiana, Illinois, Iowa, Nebraska, and Missouri, in order to make a detailed study of failures in this type of road, and a report on these inspections was published in the February, 1919, issue of Public Roads. A large number of slag-concrete roads were also inspected in the vicinity of Youngstown, Ohio, and a report was prepared on this inspection.

STANDARDIZATION OF METHODS OF TESTING BITUMINOUS ROAD MATERIALS.

Cooperation with the American Society for Testing Materials was continued through the Committee on Bituminous and Nonbituminous Road Materials. The following investigations will be of direct benefit in the standardization work of committee D-4:

- Asphalt content of oils.
- Comparison of volatilization tests.
- Chemical composition of asphalts and tars.
- Methods of making float tests.

STANDARDIZATION OF METHODS OF TESTING NONBITUMINOUS ROAD MATERIALS.

Tests were continued on a revised standard abrasion test of rock and a study is being made of an abrasion test for gravel. Steps were also taken during the year to study a new abrasion test for concrete. A new abrasion test for stone block is also being standardized and the results are available for the standardization work of the road materials committee of the American Society for Testing Materials.

CONCRETE INVESTIGATIONS.

A large number of tests were made for the concrete-ship department of the United States Shipping Board on the bond strength of steel reinforcing bars coated with protective coatings. Tests were

also made of the pressure exerted by concrete against forms when the concrete was poured at different rates. An elaborate series of tests has been planned on an investigation of blast-furnace slag for use in road and bridge construction, and a large number of samples of slag have been collected from all of the principal slag producing plants in the country. A new instrument has been designed and built in the division for measuring the wear of concrete roads under traffic. This instrument will be described in a coming report in Public Roads. Wear measurements were made on the Camp A. A. Humphreys concrete road with this instrument.

The work of testing concrete slabs was temporarily discontinued during the year but will be resumed as soon as possible. A paper based on past tests appeared in the September, 1918, issue of Public Roads. An investigation on the "Bonding of new cement mortar and concrete to old" was completed, and a paper on this subject was published in Public Roads of June, 1919.

ROAD AND BRIDGE FOUNDATION TESTS.

The field tests conducted upon earth fills in the vicinity of Washington were continued, an effort being made to determine accurately the pressures exerted by earth fills against retaining walls. Tests were also continued on the distribution of pressures through earth fills. Specimens have been prepared for conducting impact tests on road slabs. The slabs are laid directly on the subgrade and will be tested under the impact of a machine designed to give the same effect as the rear wheel of a heavy motor truck. A large number of tests have also been made to measure the impact exerted by trucks on roads and a preliminary paper has been prepared. Specimens and apparatus have also been built for a new series of tests on the wear-resisting qualities of paving sections. These sections are laid in narrow strips to a total length of 400 feet and will be subjected to rapid wear by means of a special truck designed to travel continuously back and forth over a narrow portion of the test section. Preliminary tests have also been started on the bearing power of soils with particular reference to the subgrades of roads. A field test was made on the Camp Humphreys concrete road in order to determine the distribution of concentrated loads through the road to the subgrade. A paper on this test appeared in the April issue of Public Roads. The above tests were outlined to throw light upon the theoretical design of higher types of roads.

FEDERAL-AID MATERIALS TESTS.

During the year 2,491 test reports submitted by laboratories throughout the country on samples of material used in Federal-aid road construction were examined and comments prepared regarding them. In addition, 92 specifications proposed for use in Federal-aid construction were examined and recommendations were made regarding those parts of the specifications dealing with materials.

INSTRUMENT MAKING AND REPAIRING.

Since March 5 the machine shop has been included under the direction of the Division of Tests, and during that period 28 jobs have been completed.

REORGANIZATION OF DISTRICTS.

In order to properly meet the demands that would necessarily be made upon the department as a result of this enlarged road building, it was necessary that the personnel and organization of the Bureau of Public Roads be expanded. Ten district offices had been previously established, and a sufficient number of additional engineers were assigned to each district to handle the work expeditiously. In the districts comprising the Western States where the National Forests are largely located, a number of subdistrict offices were also established to facilitate the handling of the large amount of forest road work in those districts. The necessary increase in the engineering force of the department was greatly facilitated by the return and reinstatement of a number of engineers who had previously left the department to enter the military service.

FEDERAL AID ADVISORY COMMITTEE.

Since all post road work under the Federal aid road act is done in cooperation with the several State highway departments, it was deemed advisable to devise some appropriate means for bringing about the most cordial and mutually helpful relations possible between this department and the several State highway departments. To this end there was created a Federal Aid Advisory Committee, composed of six State highway officials designated by the American Association of State Highway Officials. The State highway officials designated to serve on this committee were selected with a view to having the committee representative of the several sections of the country. It is the hope of the department that through this committee it may profit by the experiences of the respective State highway departments and become more intimately acquainted with the road problems and needs peculiar to particular States or localities.

CHANGES IN PERSONNEL.

During the year just past a number of men who had been instrumental in the upbuilding of the work of the bureau, resigned to accept positions in State and commercial work. The following are the most important changes which have occurred: Mr. J. E. Pennybacker, a member of the organization almost since its inception, chief of the Division of Economics and later chief of management, resigned in February, 1919; Mr. Prevost Hubbard, chemical engineer and chief of the Division of Tests and Research, who had been with the bureau since 1905, resigned in July, 1919; Mr. M. O. Eldridge, for 25 years connected with the bureau as assistant in economics, resigned in July, 1919; Mr. C. S. Reeve, chemist and assistant to Mr. Hubbard, who had been with the bureau since 1909, resigned in June, 1919; Mr. H. K. Bishop, district engineer of district No. 10, stationed at Washington, resigned in May, 1919.

DEATH OF DIRECTOR LOGAN WALLER PAGE.

Logan Waller Page, for many years director of the bureau, died suddenly on December 9, 1918, while attending the annual meeting of the American Association of State Highway Officials at Chicago.

Born in Richmond in 1870, he received the foundation of his scientific training in the Virginia Polytechnic Institute and the Lawrence Scientific School of Harvard University, and began his real work, which made him one of the pioneers of scientific road building in the United States when, in 1893, Nathaniel S. Shaler, then professor of geology at Harvard and chairman of the Massachusetts State Highway Commission, made him geologist and testing engineer of the commission. In this office he made the first extensive scientific investigation of road-building materials conducted in this country. He improved the French machines for testing the hardness of rocks and their resistance to wear, and evolved the Page machine for testing their resistance to impact. Tests of the binding property of rock dust and of the toughness of rock were developed in his Massachusetts laboratory, and subsequently were improved under his direction in the laboratory of the bureau.

After 7 years of valuable work in Massachusetts Mr. Page was invited to become chief of the Division of Tests in the Bureau of Chemistry in order to conduct scientific study of road building on a national scale, and when, in 1905, it was decided to consolidate all branches of highway work, he was made director of the Office of Public Roads. From a small beginning the work of the office developed and extended until at his death it was cooperating in road construction with every State in the Union.

Mr. Page realized early that in order to bring about an era of good roads the people must know about them. He organized a division of lectures and exhibits, and with a force of trained men went into the country to spread the doctrine of good roads before State, county, and town officials, farmers, bankers, and merchants. Through the building of numerous experimental roads of different types of construction and studying the service to which they were subjected true facts regarding disputed features and materials of road building were ascertained. With the early indications of the destructive influence of automobiles upon roads came studies of the nature of this wear and the publication of articles urging more durable forms of construction to meet the new conditions.

During all these years State after State established highway departments, and to not a few of these in their formative stages Mr. Page lent great and much-appreciated assistance. The departments as they were formed necessarily passed through many of the same stages of growth that characterized the growth of the Office of Public Roads. There was no official connection between the Federal and the State organizations, but there was a great deal of voluntary cooperation, and the Office of Public Roads was looked to by many of the State organizations to help solve perplexing problems. Finally in 1916 the Federal aid road act was passed and the administration of the act delegated to the Office of Public Roads by the Secretary of Agriculture. This act brought to road building national recognition, and was the logical outcome of all the yesterdays of endeavor on the part of the Federal and State organizations. The great increase in the duties and responsibilities thrown upon Mr. Page by this act, which were further intensified by the worries and perplexities which mounted higher and higher after war was declared, would have overtaxed a constitution much more rugged than his. It is a

sad commentary that when the work of a lifetime had seemed just ready to open out into a field of great national import Mr. Page's death came so suddenly and so unannounced. But his work is not ended, and even now the results are meager as compared to the great highways which are beginning to take form so rapidly. It is a great movement and has national and enthusiastic public support. But the work which he did is not forgotten or unappreciated by the road builders of the country.

REPORT OF THE CHIEF OF THE BUREAU OF MARKETS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF MARKETS,
Washington, D. C., September 23, 1919.

SIR: I have the honor to transmit herewith a report of the work of the Bureau of Markets for the fiscal year ended June 30, 1919.

Respectfully,

GEORGE LIVINGSTON,
Acting Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

During the fiscal year 1919 the work of the Bureau of Markets was directed by Mr. Charles J. Brand, who resigned June 30, 1919, to accept a commercial position.

The appropriations available were largely augmented by emergency funds, which were deemed to be necessary at the time the appropriation bills were passed in the fall of 1918. The unexpected signing of the armistice changed the aspect of the work materially, however, and it was necessary by the middle of the year to take steps to anticipate the discontinuance of emergency appropriations at the end of June and to prepare to place the Bureau on a normal basis at the beginning of the new fiscal year with as little confusion and detriment to the work as possible. The various market news services of the Bureau had been much expanded with emergency funds and this forced contraction of work made it necessary either to discontinue certain leased-wire circuits during the latter part of the fiscal year or to serve notice that such discontinuance would have to be effected in the summer or fall. Vigorous protests against this action were received, especially from the western part of the country, which was to suffer the greatest loss in service.

These reductions in appropriations caused the elimination of much work which would have an important bearing on present problems in connection with the distribution of food products. Therefore, Congress has recently been requested to provide appropriations for restoring the leased-wire services mentioned and to allow the Bureau to take up certain work which was discontinued, including monthly reports to show the amount of cereals, sugar, and canned goods held in storage, and the city market-reporting service whereby consumers may receive information regarding prices and supplies of fresh foods in important markets.

Between the time of the signing of the armistice and the close of the fiscal year, the Bureau reduced its forces greatly and this process of curtailment has continued steadily through the first months of the present fiscal year. In addition, a large turnover in personnel has taken place. The number of separations in the period indicated exceeded 800, and this added much to the difficulty of performing our work.

As stated in the report for the fiscal year 1918, the regulation of stockyards and live-stock dealers was undertaken by the Department of Agriculture in response to the proclamation of the President issued on June 18, 1918. The Chief of the Bureau of Markets was designated by the Secretary to administer the supervision of licensees under this proclamation. Supervisors have been stationed in 26 of the most important live-stock markets and in 121 additional stockyards. In the course of this work it has been possible to recommend and bring about many specific economies and improvements, and the mere fact that the regulations were being enforced caused the voluntary elimination of many irregularities and injurious practices.

The data gathered in the food supply investigations, which have been carried on for the last two years, have been arranged in a series of reports dealing with various phases of the processes of marketing live stock and grain, and several of these reports have been sent to the Federal Trade Commission to be used in connection with their reports on various phases of the food supply situation. The further prosecution of this work should lead to additional valuable results.

The distribution of nitrate of soda, originally undertaken in the 1918 season, was continued during the spring and summer of 1919. On the basis of prevailing retail prices, as reported to the Department, it is estimated that this work saved to the farmers of the country approximately \$2,000,000 during the last year alone. Nearly 153,000 tons of nitrate were distributed this year at the price of \$81 per short ton f. o. b. shipping point.

Butter was added to the commodities upon which the Bureau rendered an inspection service during the past year, though such inspections were instituted on a very modest scale, on account of the lack of funds. This service was conducted in New York, Philadelphia, Chicago, and Minneapolis and will be extended to other important markets when increased appropriations become available.

By Executive order dated December 31, 1918, the work of the domestic wool section of the War Industries Board was transferred to the Bureau of Markets for completion. The accounts received from dealers are being audited, and the excess profits made by them will be collected and distributed to the producers. It is anticipated that this work will be virtually completed during the fiscal year ending June 30, 1920.

On March 4, 1919, the cotton futures act was amended so as to limit the grades deliverable on future contracts to 10; to provide for the classification by the Department of Agriculture of all cotton delivered on future contracts on the exchanges at New York and New Orleans, entered into after March 4, 1919; and to give the Secretary of Agriculture additional authority to conduct investigations as to the purchase and sale of spot cotton in order to secure accurate quotations of the prices of the various grades. This legisla-

tion was passed because it was thought that the tenderability of certain low-grade cotton served to depress the value of contracts, because it was considered desirable to avoid the expense and delay involved in the settlement of contracts under the former plan of classification and determination of disputes, because it was believed that these steps would enhance the value of the contract both intrinsically and through increased public confidence, and because the securing and publishing of accurate quotations for spot cotton, particularly of nontenderable grades, was deemed to be of very great importance to producers and the trade.

For the sake of convenience the work of the Bureau is shown in the following detailed report under three classifications: (1) Investigational and demonstrational; (2) service; and (3) regulatory.

INVESTIGATIONAL AND DEMONSTRATIONAL WORK.

FOOD SUPPLY INVESTIGATIONS.

During the year the work of this project, which was supervised by Mr. C. S. Cole, consisted largely of the preparation of reports from the data which were obtained during the previous year and which were discussed fully in the Bureau's annual report for the fiscal year 1918. Some of these reports have been transmitted to the Federal Trade Commission for use in connection with their reports on various phases of the food-supply situation.

One report, based on records of 880 shipments of cattle, hogs, and sheep, deals with questions of transportation, shrinkage, commission charges, and miscellaneous expenses. It compares the costs of such shipments by seasons and by classes of dealers concerned, and is valuable in indicating the most economical methods of marketing live stock.

Records taken from the books of 139 elevators in Illinois and Iowa, covering a period of five years, have been analyzed in another report which deals with general expenses, profits, the seasonal flow of grain, and buying margins between country and terminal markets. This report is practically ready for publication.

The relation of so-called "wirehouses" to future trading and to the cash grain business is discussed in another report which analyzes such establishments to determine their place as a factor in terminal grain marketing and their economic usefulness. A map has been prepared showing the ramifications of the private wires centering in Chicago.

A report on terminal elevators discusses their relation to other factors in the Chicago market. It contains a summary of figures which were taken from the books of several large terminal elevators and which show the results of mixing and conditioning grain, the sources from which grain comes and to whom it is sold. The figures relating to the mixing and conditioning of grain are probably the most authentic and comprehensive ever gathered.

Figures were abstracted from the books of five large line elevators in Minneapolis dealing with 265 country stations that show the grades, weights, and dockage assessed at the country station and at the terminal. These figures cover a period of five years and include 43,000,000 bushels of various grains.

COOPERATIVE PURCHASING AND MARKETING.

This work during the latter part of the fiscal year ended June 30, 1919, was supervised by Mr. O. B. Jesness, succeeding Mr. C. E. Bassett, who resigned in December, 1918.

Personal assistance has been given in the solution of many organization problems; for example, assistance was given to dairy farmers in New England in preparing organization plans, and work of the same character was done with peanut growers in Virginia and North Carolina, bean producers in New York and Colorado, and potato growers in Michigan.

Organization problems were discussed and explained at a number of general gatherings, such as farmers' week and farm bureau meetings. Existing organizations were helped, and information relative to organization questions was supplied to a large number of individuals in this way.

A number of cooperative marketing organizations were visited to obtain information with regard to their form of organization, method of operation and problems encountered, and the general survey of cooperation in the United States, started some years ago, was continued.

State cooperative laws were studied and suggestions in regard to such legislation were given upon request. The suggested cooperative law published in Service and Regulatory Announcements No. 20 (1917) has formed the basis for at least two State laws in force at the present time, and the legislature of a third State has passed a similar law which has just been approved by the governor. Similar legislation has been under consideration in other States during recent sessions of the legislatures.

CITY MARKETING AND DISTRIBUTION.

Concentration of public interest on the high cost of food during the past year has caused a number of municipalities to take under consideration the matter of publicly owned retail markets as a means for obtaining lower prices and more efficient distribution. As a result, the project "City Marketing and Distribution," under the leadership of Mr. G. V. Branch, has been called upon during the fiscal year for surveys, information, and advice in regard to food distribution problems. Work of this nature has been carried on in Cleveland, Akron, and Toledo, Ohio; Jacksonville, Key West, Miami, and St. Augustine, Fla.; Indianapolis, Ind.; Wilkes-Barre, Pa., and Richmond, Va. In the city last named a comprehensive program for the betterment of its public market system was formulated and plans were furnished for the improvement of existing structures and for the installation of refrigeration and cold-storage facilities. The results of this work should be useful in solving comparable problems in other communities. Information and advice also have been given to other municipal governments and to market committees, farmers' organizations, and others.

Studies made in various cities indicate that meats and dairy products may be handled in their public markets at less expense to the dealer than in outside stores. The problem remains, and is receiving earnest attention, to see that the consumers participate in the savings effected by the dealers.

A number of specific market engineering problems received attention during the year and progress was made in perfecting a combined glass-covered refrigerated display and storage counter for meats, especially suited for installation in public retail markets. Studies made during the year added to the information upon which designs and estimates for market layouts, structures, and equipment must be based.

To help cities in establishing farmers' markets considerable attention has been given to the study of existing market ordinances, and an endeavor has been made to prepare a suggestive ordinance which incorporates necessary and practical provisions for the successful establishment, financing, and operation of such markets.

Investigations were carried on in various types of retail establishments handling farm products because the cost of operation in food-retailing shops is obviously an important factor in the ultimate cost of food to consumers and because the degree of efficiency attained in such operation affects the whole distribution system. Particular attention was given to what may be termed the improved methods of retail distribution, including the so-called "Four-square plan," "Self-service," "Cash and carry," etc.

The marked development of self-service stores in recent years constitutes one of the outstanding features in present-day retail marketing of food. The system is economical of man power and seems to give promise of appreciably lower prices to consumers. Little has been known generally, however, about the actual savings and the principles and methods upon which these stores depend, and the Bureau has received numerous inquiries in regard to these points. Investigations, consequently, were carried on in practically all sections of the United States in which the development of these agencies has been marked.

TRANSPORTATION AND STORAGE.

The transportation work of the Bureau is directed by Mr. G. C. White.

As in previous years, the perfecting of arrangements with common carriers for reports to be used in connection with the Bureau's market news services occupied the major portion of the time and efforts of the workers on this project. Five hundred and ninety-four common carriers made reports to the Bureau, these carriers controlling 248,722 miles, which for practical purposes is the entire mileage of the United States. The term common carrier as used in this connection includes railroads, express companies, and boat lines.

The storage work of the project was interrupted by the detail of the specialist in storage to the War Department in the latter part of October, 1918. Up to that date regulatory measures had been devised, in cooperation with the United States Food Administration, for the control of the cold-storage industry, and plans for the transportation of meats to the fighting front had been worked out in cooperation with the War Department. In order to continue the storage work, an assistant in cold-storage methods and costs was appointed temporarily and spent the remainder of the year, in cooperation with the project "Market Business Practice," in working out a system of uniform accounting for cold-storage plants.

DIRECT MARKETING ACTIVITIES.

The general aim in this work, which was under the supervision of Mr. Lewis B. Flohr, was to ascertain, analyze, and classify the factors that operate for or against the successful marketing of farm produce by parcel post or express from producers direct to consumers; to determine definitely the limitations of direct marketing both from physical and economic standpoints; and to diffuse useful information to interested persons.

During the year experimental shipments to the number of 303, involving 18 commodities and aggregating in weight 6,856 $\frac{1}{4}$ pounds, were made by parcel post and express over distances totaling 63,164 miles. The purpose in making these shipments was to obtain first-hand information as to the physical condition of farm produce transported by parcel post and express and to test the efficiency of different kinds of shipping containers. In nearly every instance the success of the shipments depended on the quality of the product, the type of container, care used in packing and transporting, and length of time in transit. The value of a commodity in proportion to its weight and the price which it will bring are factors which must be considered in determining the desirability of marketing by parcel post and express.

Field studies were made in the vicinity of Detroit, Mich., and on the rural parcel post motor routes from Washington, D. C., to McConnellsburg, Pa., to determine the possibilities of the direct marketing of farm products by motor truck, and to ascertain the relative success of efforts that have been made to popularize direct marketing.

In the New England States and in eastern New York work was conducted for the purpose of bringing producers and consumers into business contact. Lists of names and addresses of farmers, with the kinds of products they had for sale, were compiled, and copies of these lists were supplied to consumers in cities. Lists giving consumers' names, addresses, and products wanted were supplied to producers. Similar work was conducted for six months in western New York with Rochester, Corning, and Lockport as consuming centers.

During the year study was completed regarding the marketing of dressed poultry and meats by parcel post, and, in cooperation with the States Relations Service, assistance has been given to extension workers in solving problems relating to the marketing of boys' and girls' club products.

Studies have been made regarding the marketing of home and club canned goods, drug plants, moss, mushrooms, nuts, sirups, and teasel heads.

MOTOR TRANSPORTATION OF FARM PRODUCTS.

This work was started in March, 1918, and was continued up to the close of the fiscal year 1919 under the direction of Mr. J. H. Collins.

Widespread popular interest has for some time been manifested in agricultural districts in the possibilities of obtaining more direct transportation service through more complete utilization of our highways, and this work was designed to assist in the development of this movement along proper lines. Direct cooperation was maintained with owners and operators of existing motor-truck routes.

An accounting system designed to indicate costs of operation and approved forms for shipping records were devised for the use of operators of motor routes. Emphasis was placed on the necessity for the adequate insurance of cargoes, and provisions to be incorporated in cargo insurance policies were suggested after consultation with responsible underwriters. The advantages resulting from the use of proper terminal facilities were pointed out, and the possibilities of establishing central terminal facilities for all routes in certain cities were investigated. Eight demonstration routes were established and operated successfully. Studies also were made of the operation of farmers' cooperative truck associations, and a preliminary survey of the marketing of live stock by motor truck was conducted in certain live-stock centers. This study, which was completed during the fiscal year, was principally confined to farm areas in New Jersey, Maryland, Pennsylvania, western New York, northern Ohio, and eastern Nebraska. Two bulletins listed at the end of this report were published and give results of this study. These publications have been in wide demand.

MARKET BUSINESS PRACTICE.

The work of this project was somewhat interrupted during the year by the loss of technical men through resignation, enlistment in the military service, or assignment to other war work. On account of this condition, a large portion of the regular work was suspended.

As a result of the past three years' work a manuscript outlining a uniform classification of accounts for creameries has been prepared. This manuscript discusses many of the undesirable business practices employed by creamery managers and points out the procedure which should be followed.

Further investigation of the accounting and business practices of milk-distributing plants has been made, and advice regarding proper procedure and methods has been given to a number of plants. The procedure under the system installed for experimental operation at Grand Rapids, Mich., and at Burlington, Vt., has been carefully observed and perfected.

The operation of a tentative system of accounting for purchasing organizations and cooperative stores has been carefully studied and as a result a manuscript describing the accounting methods and business practices of such organizations has been prepared.

With the promulgation of official grades for grain, it became evident that it would be desirable to revise the methods of accounting which were recommended for grain elevators outlined in Department Bulletin No. 362, and after a great deal of study a manuscript suggesting changes was prepared. In addition to this, the methods employed in marketing grain in the Pacific northwest were studied with a view to devising a system of accounting to meet the peculiar needs of that section.

A tentative system of accounting for cold-storage plants was devised and installed for experimental operation at Boston, Mass., and has been carefully watched during the year. Extensive investigations of the business practices and accounting methods of cold-storage plants have been conducted, and numerous conferences have been held with leaders of the industry.

Investigations of the methods of accounting used by and the business practices of commission houses and handlers of perishable fruits and vegetables were completed, and tentative accounting systems were installed in eight organizations for experimental operation.

As a result of extensive investigation regarding the accounting needs of cotton gin operators, a system of accounting for such agencies has been devised and is now ready for experimental operation.

Methods of demonstrating the work in accounting and business practice have been given careful consideration and it should be possible to obtain very good results by using the bulletins as a basis for short courses for managers and bookkeepers of marketing organizations. A large number of State schools and colleges have expressed a desire for material of this character upon which to base such courses.

FOREIGN MARKETING INVESTIGATIONS.

The signing of the armistice on November 11, 1918, marked the beginning of unusual activity among producers and exporters in preparation for the resumption of foreign trade, and extensive demands have been made for information concerning foreign marketing conditions. Studies were made regarding the marketing in foreign countries of such American agricultural products as grain, grain products, rice, seeds, cotton, vegetable oils, oil cake, dairy products, live stock, and meats; fresh, dried, and canned fruits and vegetables; and honey, nuts, and leaf tobacco. A large number of official and private foreign publications were reviewed regularly and abstracts and translations were made from them for use in answering correspondence and for publication. The work of this project was directed by Mr. C. W. Moomaw.

Statistics covering exports of agricultural products from the United States by 10-day periods were tabulated during the year, although this work was discontinued in June. Information assembled from steamship manifests at the New York customhouse was used in the publication of daily and weekly reports on the current exports and imports of live stock, meats, dairy products, grain, fruits, and vegetables.

Cooperation was maintained with an interdepartmental committee appointed to classify the export and import statistics published by the Department of Commerce, and for several months work was done in the revision of the classification for agricultural commodities. It is expected that this reclassification will be put into effect January 1, 1920.

To meet the demand for information on foreign markets the publication of a weekly circular entitled "Reports on Foreign Markets for Agricultural Products" was commenced in March, 1919. This publication has been widely circulated and favorably received.

An investigation concerning the fruit markets in Australia and New Zealand was completed in November, 1918, and a report on this subject was prepared for publication. Coincident with this investigation the live stock, meat, wool, and dairying industries of Australasia were studied.

As a result of representations made by an investigator of this Bureau through the American consul general at Auckland, the Gov-

ernment of New Zealand opened its markets to American grapes, which previously had not been allowed entry into that country.

In cooperation with the project "Marketing Live Stock, Meats, and Animal By-Products," an investigator was sent abroad to study the conditions in the live stock, meat, and dairy industries of the United Kingdom and Europe, and to estimate the possible demands upon America during the readjustment period. During the visit of this representative to France the Ministry of Agriculture removed existing restrictions against the importation of American cattle and placed an order in the United States for large numbers of dairy cattle. This Bureau also was instrumental in making an arrangement with the United States Shipping Board whereby these cattle could be shipped to France.

In June, 1919, in cooperation with the project mentioned above, representatives were sent to South America to study the markets for American purebred live stock. In connection with this work attractively illustrated booklets printed in Spanish and Portuguese were issued dealing with the purebred live-stock industry of the United States.

At the request of the relief commission the Bureau of Markets, in February, 1919, sent a grain expert to Europe to assist in estimating the crop and food conditions in the central countries.

In May, 1919, an agricultural trade commissioner was sent to the United Kingdom to study the markets for American agricultural products in that region and to make regular reports by letter and cable on this subject for the information of the American public. Representatives of the same sort should be placed in France, Italy, and Denmark for work in central, southern, and northern Europe, but at present funds will not permit this expansion.

RURAL COOPERATION.

This work was prosecuted under the supervision of Mr. C. W. Thompson during the past fiscal year. The supervision and direction of the investigations concerning rural insurance, rural telephone companies, and rural social and educational activities was, at the end of the year, transferred to the Office of Farm Management in accordance with the plans of the department for an enlargement of the field of that office to include all studies pertaining to farm economics and farm life. The rural credit investigations were discontinued since Congress failed to appropriate funds for the further prosecution of this work.

RURAL CREDIT, INSURANCE, AND COMMUNICATION.

During the fiscal year 1919, a study was made of the farm credit extended by banks, assistance was given the Bureau of the Census in the preparation of the 1920 census schedule, press releases and other material relative to farmers' credit unions in the United States were prepared, and a number of articles on rural credit were published.

A model State law was drawn up for farmers' mutual fire insurance companies, a manuscript for a bulletin on prevailing plans and practices among farmers' mutual fire insurance companies was

prepared, a suggested system of records for such companies was completed, assistance was given in the formation of two new State associations of mutual insurance companies, and special attention was given to the study of hail insurance and other special forms of agricultural insurance.

RURAL SOCIAL AND EDUCATIONAL ACTIVITIES.

Information was assembled regarding the more important farmers' organizations for promoting rural social and educational activities, a list of State and local fairs was compiled and brought down to date, the study of rural community buildings was continued, and a bulletin on this subject was prepared for publication.

FOOD SURVEYS.

The food-survey work, conducted under the authority of the food production act and directly supervised by Mr. C. W. Thompson, was brought to a close on June 30, 1919, with the expiration of the emergency appropriation.

Monthly reports of commercial stocks of foodstuffs in the hands of selected classes of business concerns were published throughout the year in a periodical entitled "Food Surveys." These reports covered 22 different commodities and were based upon schedules received from about 20,000 firms each month.

General surveys were made as of July 1, 1918, and January 1, 1919, covering 67 and 68 commodities, respectively. The survey of July 1, 1918, included retail dealers, while that of January 1, 1919, was confined to manufacturers, storage establishments, and wholesale dealers. The data obtained through these surveys were published in considerable detail in special issues of "Food Surveys," with diagrams presenting the most significant facts in graphic form.

Tabulation of the results of the household survey, for which the schedules were assembled in the early part of 1918, was completed and a report was prepared comprising tables, diagrams, and explanatory text, and showing per capita consumption and household stocks per family.

Reports regarding the amount of wheat and other grains thrashed in the United States were secured from thrashermen, in cooperation with the States Relations Service, and the results of this inquiry were supplied to the Bureau of Crop Estimates.

COOPERATION WITH THE STATES IN MARKETING WORK.

The Bureau of Markets cooperated with 22 States in the conduct of marketing work during the fiscal year 1919—namely, Arkansas, Colorado, Connecticut, Georgia, Indiana, Iowa, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Mexico, North Carolina, Ohio, Oregon, Tennessee, Texas, Vermont, Virginia, and Washington.

The marketing work in each of these States is under the immediate leadership of a State agent in marketing, whose function it is to assist in coordinating the marketing work done by various agencies in the State concerned. In the majority of the States these agents have assistants engaged on special phases of marketing, four or five men being employed in some cases.

During the fiscal year 1919, Mr. J. C. Skinner represented the Bureau of Markets in the administration and supervision of this work from Washington. In some States general surveys were conducted to obtain information regarding the marketing methods in use and the kinds of assistance most needed. Special investigations regarding the marketing of specific commodities have been conducted from time to time. The State agent in marketing acts as a clearing house for information regarding supply and demand, markets for all sorts of farm produce, and many other matters.

In many States assistance was given in the organization of livestock shipping and other cooperative associations. By-laws for such associations were prepared and accounting systems installed to insure the businesslike management of such agencies. A great deal of work was done in the drought areas of the West in locating supplies of hay and feed to be shipped to owners of stock. The United States Railroad Administration assisted in this work by allowing a half freight rate. In the Southern States much work has been done to interest the growers of sweet potatoes in building storage houses to prevent the waste which now occurs in connection with the storage of this crop. Demonstrations of packing and grading fruits, vegetables, and grain have been held and other work has been done to promote better marketing methods.

MARKET GRADES AND STANDARDS FOR FRUITS AND VEGETABLES.

Under this project, which was directed by Messrs. W. M. Scott and C. T. More, the Bureau continued its investigations of the harvesting, grading, packing, and shipping of fruits and vegetables. The scope of the work during the past year, however, was relatively limited because of the loss of experienced men to the military and naval services.

Throughout the country an increasing interest has been shown in uniform grades for fruits and vegetables. The work of the United States Food Administration in enforcing the acceptance of shipments and adjusting claims and the results brought about by the operation of the Food Products Inspection Service did much to demonstrate the necessity of establishing definite standards.

In the principal apple-producing sections of the country information was gathered for use in making specifications for grades of both barreled and boxed apples. As a result of the investigations in the eastern part of the country, a bulletin has been prepared dealing with the preparation of barreled apples for market. Recommendations regarding improved equipment and operating methods for central packing houses in the East have been made. In cooperation with the West Virginia Agricultural College tentative plans were drawn for the erection of a demonstration packing house in the State, and methods for equipping it were recommended. In the Western States a keen interest has been shown in securing uniform State apple grades, and recommendations were recently made at a western conference that uniform grades for boxed apples be established.

Investigations carried on in Georgia and Virginia developed the need of an improved type of peach-sizing machine, and such a machine was built and installed in Georgia. An improved model is now being perfected and the study of peach grading and peach packing houses has been continued.

On January 31, 1918, orders were issued making compulsory upon the part of licensees of the United States Food Administration the use of the potato grades prepared by the Bureau of Markets, which were jointly recommended by the Department of Agriculture and the Food Administration in September, 1917. Following the signing of the armistice these regulations were canceled. A striking improvement in the grading of potatoes resulted from the recommendation and promulgation of these standards, and the best indication of the need for national standard grades is the fact that these grades for potatoes are still voluntarily in as wide use as they were before the regulations making their use compulsory were canceled six months ago. Several States have adopted these grades and made their use compulsory. As a result of continued demonstrational and investigational work minor changes in these grades were recommended on February 10, 1919, and specifications for a fancy grade have been worked out. This fancy grade will be used largely for the large, smooth, bright potatoes produced in the irrigated sections of the West.

The grades recommended by the Bureau of Markets for domestic Bermuda onions were again used by the Texas State inspectors during the past season. The grading of northern or late onions is now being studied in order that grade specifications may be recommended by the end of the 1919 season.

Investigations of the grading of tomatoes, cabbage, and of some other vegetable crops have progressed to the point where it is believed that grade specifications can be recommended in time for use during the next harvesting season.

Study of the containers used in the marketing of perishables has progressed in a very satisfactory manner during the past fiscal year. Growers, shippers, manufacturers, and the produce trade are showing a greatly increased interest in package standardization.

PRESERVATION OF FRUITS AND VEGETABLES IN TRANSIT AND STORAGE.

During the greater part of the fiscal year 1919 this work was under the supervision of Mr. H. J. Ramsey and after his resignation was directed jointly by Messrs. C. W. Mann and A. W. McKay. Anticipating the fact that the funds for this project would be greatly reduced by the elimination of the emergency appropriation on June 30, 1919, it was necessary to adopt a policy of curtailment during the closing months of the past fiscal year and to dismiss many trained investigators.

Particular attention was given to the methods of handling potatoes in the Delta section of California; cantaloupes in California, Arizona, Colorado, and Indiana; and lettuce, tomatoes, spinach, and onions in the Gulf States and Florida. Demonstrations were made to point out to growers that decay in the transportation of these products is primarily due to faulty methods of handling and refrigerating. Marked reductions in losses resulted from the application of more careful methods of digging and grading potatoes and the maintenance of suitable temperature in refrigerator cars and storage houses and by effecting certain improvements in the handling of lettuce, such as the more complete removal of the lower leaves of each head in harvesting, and shipment in ventilated crates instead of closed hampers. It was found that the decay of strawberries in

transit results largely from avoidable injuries inflicted in picking and washing operations and from inefficient refrigeration.

Additional data were secured regarding the effect on the keeping qualities of perishables of various types of refrigerator cars, methods of loading, etc. Vegetables from the South shipped in properly constructed cars cooled 1° an hour faster than those forwarded in cars of the ordinary type and deteriorated less than one-third as much. Experimental shipments to determine the practicability of the use of salt and ice to secure more rapid cooling were continued, and a survey of icing stations was undertaken with a view to suggesting means of reducing present losses of ice.

The fundamental principles underlying the proper design and construction of heater cars for use in the northern sections of the country, where severe losses occur in shipments during cold weather, were carefully studied in a special testing plant equipped by the Bureau for this purpose at Roseville, Calif. Specifications for heater cars, based on the results of these tests, have been adopted by the Railroad Administration.

Investigations and demonstrations regarding the factors underlying the successful storage of fruits and vegetables were continued. In the Pacific northwest and in Colorado 40 common storage houses for apples and more than 200 potato-storage houses and cellars were built or modified in accordance with plans or suggestions furnished by this Bureau, and the capacity of sweet potato storage houses built in the South directly or partly as a result of this demonstrational work amounts to about 3,000,000 bushels.

The introduction several years ago by the Department of methods of packing California grapes in redwood sawdust resulted in extending the marketing season of such grapes nearly three months and in widening the possible area of distribution. On account of a shortage of redwood, efforts have been made to find a substitute, with the result that spruce, a material hitherto untried, has been found to be very effective. Further demonstration of the practical value of spruce packing will be made next season. The curtailment of this grape-growing industry from the lack of a suitable filler will be avoided should spruce, of which there is a very large supply on the Pacific coast, prove to be as satisfactory a packing material as redwood.

Comprehensive investigations have been conducted to determine the best methods of handling fruits and vegetables which have been injured by freezing in transit, and demonstrations have been made to illustrate practicable methods of salvaging frozen or partly frozen products, attention being called to the possibility of their use both for food and manufacturing purposes. The temperatures at which various products freeze or are injured by excessive chilling have been studied and preliminary investigations have been carried on to determine the factors which affect the keeping quality of fruits and vegetables preserved by freezing storage.

DAILY MAIL REPORTS OF CAR-LOT SHIPMENTS OF FRUITS AND VEGETABLES.

UNLOAD REPORTS.

Daily mail reports of car-lot shipments of all fresh and dried fruits and vegetables have been obtained from common carriers during the

past fiscal year. The railroad lines, express companies, and the principal boat lines originating such shipments have cooperated heartily in this work. The scope of these mail reports grew during the year, so that about 110 different commodities are now included, and approximately three-fourths of a million carloads of fresh and dried fruits and vegetables were reported. It was found necessary during the fiscal year to discontinue the publication of the semi-weekly shipment report, which was based on these daily mail reports.

The reports of fruits and vegetables unloaded in 16 of the principal markets have been somewhat diminished in scope during the past year and are now obtained for the following commodities only: Apples, cabbage, cantaloupes, celery, onions, peaches, strawberries, tomatoes, white potatoes. This project is supervised by Mr. W. A. Sherman.

MARKETING DAIRY PRODUCTS.

The work of this project was supervised by Mr. R. C. Potts during the fiscal year 1919.

Surveys of milk-marketing conditions, including the sources and amount of available supplies, the demand for and methods of distributing fluid milk and cream, were made at Sedalia and Kansas City, Mo.; Leavenworth and Kansas City, Kans.; and Cumberland, Md. Reports on these surveys were prepared and recommendations were made for the improvement of marketing methods and conditions in the cities named.

Special attention was given to problems connected with the business management and operation of city milk-distributing plants, especially those owned and operated by farmers' cooperative companies.

Field campaigns to increase the demand for and distribution of cottage cheese were conducted in New York, Massachusetts, and Connecticut with most satisfactory results.

Special investigations were made of the production, consumption, and prices of casein in the United States to determine the possibility of furnishing adequate supplies for war needs by domestic production. The results of the investigations were made available to the Aircraft Construction Division of the Navy Department and to the War Trade Board.

The size of existing stocks and the prices of milk powder were investigated for the purpose of obtaining definite information regarding market conditions which were reported to be injurious to the development of the milk powder industry. Investigations proved, however, that the alleged conditions did not exist.

Studies of the sources of supply, production, demand, prices, and market conditions of butter and cheese were made. It is hoped that complete statistics on this subject may be published for the years 1917 and 1918.

MARKETING LIVE STOCK, MEATS, AND ANIMAL BY-PRODUCTS.

This project is under the supervision of Mr. Louis D. Hall and furnishes the fundamental information upon which the market news service and the regulatory work connected with live stock and meats are based. The information obtained by this project served as a guide in preparing the regulations governing licensees operating

stockyards or dealing in live or dead stock at stockyards and was useful in planning and directing the stockyards' supervision service.

A survey of the marketing of purebred live stock in the United States was begun early in the fiscal year in order that the Bureau might be prepared to render assistance in reestablishing the live-stock industry in the devastated countries of Europe. As a result of this survey, information was made available showing the location by counties of the majority of breeders engaged in the production of each of the principal breeds of live stock. This information is being used to aid buyers and sellers in both domestic and foreign trade.

The detailed study of the problem of marketing soft pork which was begun during the latter part of the last fiscal year was continued in order to determine a basis for the difference in prices which should be paid for live hogs classed as "soft" or "oily" and those classed as "firm." The results of this study now are being prepared for publication.

An investigation was made in cooperation with the Bureau of Animal Industry and the Bureau of Chemistry to determine the reasons for numerous complaints regarding the country hide situation, especially with reference to the physical condition of country hides and skins and the apparent discrimination in the prices for these products, both at the farm and on the market, and to ascertain what improvements could be effected. As a result of this work a bulletin was prepared and educational posters bearing general instructions regarding proper methods of skinning, curing, and marketing hides were printed for distribution.

A preliminary, country-wide study has been made to obtain definite facts relating to the various types of retail meat stores and more complete information relative to the costs of distributing meats at retail.

Careful studies were made of the present commercial grades for wool, and a collection of samples was made preparatory to the development of tentative standards for various grades of wool. Circulars were prepared and distributed suggesting better methods of preparing and marketing wool, and direct marketing was encouraged where possible by putting wool producers into possession of information regarding direct channels for marketing their clips. During the war active cooperation was maintained in connection with this work with the War and Navy Departments, the Council of National Defense, War Trade Board, War Industries Board, Shipping Board, and Tariff Commission.

GRAIN MARKETING INVESTIGATIONS.

Emergency activities of pressing nature made it necessary to restrict in a measure this investigational work. Mr. C. S. Cole supervised the project during the past fiscal year.

Studies of the methods of marketing grain sorghums, the kind marketed, and the demand for and uses of such grains were carried on in the principal producing and consuming sections. These investigations show that milo and kafir are the principal grains used to feed all classes of live stock in producing sections, and also are used in practically all mixed poultry feeds in the leading poultry sections of the United States. These grains also are used in the manufacture of starch and alcohol and for human food.

Investigations of a preliminary character have been carried on with regard to the marketing of broom corn. Information has been obtained from local freight agents regarding the amount of standard and dwarf varieties shipped from stations in important producing territories, and the uses and distribution of broom corn have been studied as a basis for more specialized future investigations.

SEED MARKETING INVESTIGATIONS.

During the first half of the fiscal year ending June 30, 1919, investigations were made to determine the effects of the war on commercial seed production, seed imports and exports, domestic demand, size of stocks carried, prices, etc.

A study has been made of seed marketing on the farm and much information has been obtained. Among other things, these data include, in percentages for the various classes of seed, the sources of the farmers' seed supply in every State and show how he prepares and disposes of his seeds.

Some of the leading seed markets in Europe were visited in order to make recommendations for increasing and stabilizing, if possible, the seed trade between the United States and European countries.

Production and consumption maps for clovers, grasses, millets, sorghos, cowpeas, Canada field peas, and soy beans were prepared in order to show the counties normally having a surplus, sufficiency, or deficiency of each of the kinds of seeds.

These investigations were supervised by Mr. W. A. Wheeler.

GRAIN STANDARDIZATION AND GRAIN HANDLING AND TRANSPORTATION.

During the last fiscal year investigations were made of factors to be considered in formulating standard grades of oats, barley, rice, and flaxseed. This and other related work, as well as certain investigations regarding grain handling and transportation, were supervised by Mr. S. A. Regan.

As a result of the investigations concerning oats, official standards for this grain were promulgated under date of March 14, 1919, to become effective June 16, 1919. Before promulgating the standards a series of hearings were held throughout the United States to obtain the opinion of the grain trade as to their workability.

Specifications for tentative or permissive standards for milled rice were prepared and announced in Markets Document No. 15, issued September, 1918. A supplemental publication relating to standards and entitled "Instructions for the Sampling, Handling, Analyzing, and Grading of Samples of Milled Rice" was published as Markets Document No. 16, in October, 1918. These standards were adopted by the United States Food Administration and used by its rice committee in grading all rice purchased by the Government for the Army, Navy, Belgian relief, and the allied nations. The several rice-grading offices of the United States Food Administration were visited from time to time and instructions in grading were given so that the tentative standards might be correctly interpreted.

Much work has been done to determine the practicability of cleaning grain by means of special attachments on thrashing machines. These investigations have resulted in the development of a special pneumatic cleaner to be attached to the thrashing machine, which is proving effective.

Careful investigations have been made to determine the effect of storing wheat and barley in concrete and steel bins. These studies were conducted in cooperation with the Food Administration Grain Corporation. Manitoba wheat, containing approximately 15 per cent of moisture, was placed in large steel tanks holding over 100,000 bushels. This wheat kept sweet for several weeks, although the temperature of the air beneath the steel roofs during warm, bright days reached 120° F. and higher during midday. There was no apparent change in the wheat except that it lost moisture around the steel sides and on top of the grain. This wheat was later transferred to concrete tanks and its behavior in them is being studied.

A cargo of wheat was accompanied from Philadelphia to Genoa, Italy, to determine the effect of grade factors on the keeping qualities of different lots of wheat during ocean transportation. In this connection, two other cargoes of wheat shipped from the United States were sampled at the Italian port of arrival and information was obtained on their condition at the time of discharge. The data on this work are being assembled for study in connection with efforts to assure the arrival of American grain in good condition in foreign ports and to perfect the grain standards to meet the requirements of ocean transportation. Samples have been collected from a boat loading at Astoria, Oreg., to determine the carrying qualities of the western-grown wheats which will pass through the Panama Canal to Europe.

COTTON HANDLING AND MARKETING.

The investigational and demonstrational work connected with cotton handling and marketing was conducted during the past year under the direction of Mr. Fred Taylor and later, owing to Mr. Taylor's resignation, by Mr. D. E. Earle. Mr. Taylor also supervised, until his departure, the projects "Marketing Cotton Seed and its Products," "Investigation and Demonstration of Cotton Standards," "Cotton Testing," and "Preparation and Distribution of Official Cotton Standards."

Demonstrations have been made to acquaint producers with the desirability of classifying their cotton before sale and to teach them how to use market quotations in determining the value of their crop. Approximately 236,360 bales were classed in this work in Texas, Arkansas, Louisiana, Mississippi, North Carolina, and South Carolina during the cotton season 1918-19. In addition to this, representatives of the Bureau assisted in organizing growers on a community basis, demonstrated the depressing effect of short-staple varieties upon prices, and pointed out losses incident to improper ginning, baling, and storing. This work has resulted in the enactment of State laws for the betterment of cotton-marketing conditions, especially in Texas, Arkansas, North Carolina, and South Carolina. These activities were conducted in cooperation with the extension divisions in the various States.

Texas growers, producing cotton of good staple and marketing it cooperatively, receive from 1½ to 8 cents more for their cotton than was received for other cotton grown in the same community and sold by individual farmers.

A complete survey was made in Arkansas to determine the character of cotton produced and the conditions under which it was marketed. Approximately 76,500 bales of cotton were classed at

Little Rock from samples sent in by ginnermen from 70 different counties of the State. A detailed study of the information gathered in this survey is being made for the benefit of the growers. The commissioner of mines, manufactures, and agriculture and the extension forces of the State cooperated actively in this work.

About 93 growers of Mississippi and Louisiana formed a cooperative association, and with the aid of a director of the Louisiana extension service and a representative of this Bureau, availed themselves of the advantages of marketing on the basis of grade and staple. Many of these planters used the classifications made by this representative in the course of his demonstrational work as a basis for settlement with their tenants.

Demonstrational cotton marketing work was carried on last season at Raleigh, with branch offices at Tarboro, Wilson, and Lumberton, N. C., and at Darlington, Sumter, and Orangeburg, S. C. Approximately 85,000 bales were classed in these States. A survey also was made of the mills of both States with a view to determining the kind of cotton consumed, prices paid for such cotton, and the channels through which it was obtained. As a result of several years of continuous investigational and educational work associations have been formed in these States for the purpose of marketing cotton direct. The association at Orangeburg, S. C., has employed a seller who makes outside connections, assembles the cotton in large even-running lots, and sells direct to the representatives of mills and exporters.

MARKETING COTTON SEED AND ITS PRODUCTS.

Efforts to lessen the large amount of foreign matter, which annually is purchased, handled, and transported with cotton seed, have been continued as important economies could be effected if more care were taken in cleaning and protecting this product.

Investigations to determine the practicability of establishing standards for cotton seed have been continued, and an investigation has been undertaken to ascertain the average oil and ammonia content normally contained in seed grown in different sections of the cotton belt. The possession of such knowledge and the use of practical standards would enable millers and producers to trade on the basis of merit. An investigation also was instituted, in cooperation with the Bureau of Chemistry, to determine the relative qualities of different varieties of cotton seed when grown under practically the same conditions. It is hoped that this investigation will enable the Department to promote the growth of varieties that are superior both as to lint and oil.

Investigations have shown that in many instances cotton seed brought to the gin contains a large percentage of moisture. If the seed is not immediately crushed, this moisture often causes damage by inducing fermentation. It has also been found that cotton seed is often sold without reference to the moisture content, which has a most important bearing on its value.

A survey has been started, in cooperation with the Bureau of Plant Industry, to obtain information regarding the world's oleaginous materials and their products. The importation of these commodities into the United States has increased greatly during the past several years. This work was directed by Mr. Fred Taylor, assisted by Mr. C. F. Creswell.

COTTON WAREHOUSING INVESTIGATIONS.

A series of tests to determine the practicability of gin sampling and the extent of the damage sustained by baled cotton when exposed to the weather has been concluded and the results are being prepared for the use of the public. Standard warehouse designs have been prepared and persons adopting them are given the benefit of careful cooperative supervision in an effort to promote the construction of warehouses in accordance with the most advanced ideas. This work should save insurance costs and should aid in obtaining better warehouse service. A comprehensive bulletin on cotton warehouse design and construction is now in press.

These investigations are directed by Mr. R. L. Nixon.

INVESTIGATION AND DETERMINATION OF COTTON STANDARDS.

This work was supervised by Mr. Fred Taylor, assisted by Mr. D. E. Earle.

On the 25th of October, 1918, grade standards were officially promulgated for Sea Island and American-Egyptian cotton and for length of staple, this action being the result of careful investigations undertaken in previous years.

In Arizona and California investigations were conducted to determine the applicability of the standards for American-Egyptian cotton to the crop of the past season. These investigations showed that the bulk of the 1918-19 crop conformed very closely to the standards. Marketing and shipping conditions were studied and laboratory tests were made to ascertain the moisture content and the breaking strength of the individual fibers of this cotton. Investigations also were made regarding its spinning qualities, waste, breaking strength, and weights upon arrival in the East. In the course of this work approximately 10,000 bales of cotton were classed.

A survey was made during the fiscal year at the principal marketing centers to determine the applicability to the past season's crop of the standards for Sea Island cotton. Several thousand samples were compared with the established standards and were found to conform with them approximately, except in a portion of the lower grades, which were somewhat bluer in color than the corresponding grades in the standards. Authentic information was gathered regarding the crop, prices received, and general marketing conditions.

COTTON TESTING.

The regular cotton-testing work of the Bureau was resumed during the past year after completion of the tests which were made in connection with the production of an improved airplane fabric for the War Department.

Preliminary tests were made to determine the relative spinning values of Sea Island and Meade cotton, which latter compares very favorably with inland Sea Island cotton.

A comparison was made of the manufacturing properties of "Middling Yellow Stained" cotton with an equal grade of cotton which was harvested and ginned before the fiber had reached a normal state of maturity, popularly known as "bolly" cotton. It was found that

the total waste, exclusive of tare, from the "Middling Yellow Stained" cotton was 10.6 per cent and the total waste, exclusive of tare, from the "bolly," 16.8 per cent. Tensile strength tests proved that "Middling Yellow Stained" cotton was about 10 per cent stronger than the "bolly" cotton.

At Tempe, Ariz., tests were made to determine the advisability of using artificial humidity during the ginning process. This test showed no difference in the spinning value of the cotton ginned with and without artificial humidity.

This work was supervised by Mr. Fred Taylor assisted by Mr. D. E. Earle.

SERVICE WORK.

MARKET NEWS SERVICES.

Anticipating the discontinuance of emergency appropriations, some of the leased wire circuits of the Bureau, which formerly extended 15,000 miles, were abandoned before the close of the fiscal year 1919. On June 30 the leased wires used in connection with the live-stock news service were discontinued west of Kansas City and south of Cincinnati. The circuits used in connection with the services on fruits and vegetables and dairy products will be closed throughout the West on September 30 if no additional funds are made available. On account of the importance of this work as a factor in promoting the effective provisioning of our great cities with fresh food, and the undesirability of leaving the West and South without reliable market information, Congress has been requested to grant additional funds for this work. The leased wires now extend about 9,000 miles, having been reduced from the mileage mentioned above.

MARKET NEWS SERVICE ON FRUITS AND VEGETABLES.

As stated in the annual report for the fiscal year 1918, this work was greatly expanded with war funds and it was operated on this basis during the greater part of the past fiscal year, although, anticipating the discontinuance of emergency funds, many curtailments were effected during the last half of the year. Mr. W. A. Sherman is in charge of this work.

Reports were issued covering 31 commodities. These reports gave information regarding car-lot shipments, arrivals, and jobbing prices in the principal markets, and f. o. b. prices and other shipping-point information.

The following commodities were included in the program of the past fiscal year:

Apples.
Asparagus.
Bunched vegetables.
Cabbage.
Celery.
Cherries.
Cantaloupes.
Cranberries.
Cucumbers.
Dry beans.
Eggplant.

Grapefruit.
Grapes.
Green peas.
Honey (semimonthly).
Lettuce.
Mixed fruits.
Onions.
Oranges.
Peaches.
Pears.

Peppers.
Prunes.
Spinach.
Strawberries.
String beans.
Sweet potatoes.
Tangerines.
Tomatoes.
Watermelons.
White potatoes.

During the greater part of the past fiscal year 32 market stations were operated in important consuming centers throughout the United States, as follows:

*Atlanta.	Detroit.	*New Orleans.
*Birmingham.	*Fargo.	*Oklahoma City.
Boston.	*Fort Worth.	Omaha.
*Buffalo.	*Houston.	Philadelphia.
*Butte.	*Indianapolis.	Pittsburgh.
Chicago.	*Jacksonville.	Portland.
Cincinnati.	Kansas City.	St. Louis.
Cleveland.	Los Angeles.	San Francisco.
*Columbus.	*Memphis.	*Spokane.
Denver.	Minneapolis.	Washington.
*Des Moines.	New York.	

NOTE.—Stations marked with an asterisk discontinued during spring of 1919.

Temporary field stations were operated during the year 1918 at 71 points in the various producing sections during the important car-lot movement of the principal commodities listed above, 82 such stations having been maintained in the previous fiscal year.

There was a marked increase in the number of market reports distributed from market and field stations by telephone and telegraph during the past fiscal year. Subscribers receiving reports by telegraph pay the usual commercial charges on such messages. During the year 1918 the market stations released about 17,000 reports by telephone and 1,100 by telegraph. The temporary field stations in producing sections distributed approximately 2,600 reported by telephone and 1,500 by telegraph.

Approximately 23,000,000 mimeographed daily market reports were issued during 1918 to approximately 125,000 individuals throughout the country.

In addition to the daily market reports, a special "Weekly Review" of the markets was prepared in Washington. This Review was based on daily reports of the movement and prices of the important commodities and showed the trends and tendencies of the markets both in consuming and producing centers. It was sent to about 7,000 interested persons and to leading newspapers, trade publications, and farm journals.

The "Weekly Summary of Car-lot Shipments," showing the movement of the various commodities from each State during the preceding week as compared with the movement of the week previous and of the corresponding periods last year, was sent to transportation officials, members of the trade, educational institutions, and others interested in such statistics.

Semimonthly reports were released to about 3,000 persons interested in the honey shipments and markets.

MARKET NEWS SERVICE ON LIVE STOCK AND MEATS.

The market news service on live stock and meats, which is conducted under the direction of Mr. Louis D. Hall, was much expanded by the use of emergency funds as stated in the annual report for the previous fiscal year. With the expiration of these funds the service was greatly curtailed on July 1, 1919, all leased wires west of Kansas City and south of St. Louis having been closed.

During the year a branch office was established at San Francisco, and the service was extended temporarily to Jacksonville, Fla., Indianapolis, and Cincinnati. By these additions the number of branch offices with leased-wire service was increased to 20. The daily reports on meat trade conditions were continued with the addition of price quotations on wholesale pork and veal cuts. These reports were expanded to include trade conditions and prices at Chicago and San Francisco and a "flash wire" indicating the trend of early trading also was added. Both the daily and weekly reports were improved by condensing the text, which made them more readily useful to the trade. Approximately 3,500,000 copies of each of the various daily reports and 750,000 copies of the weekly reports were distributed during the year.

Early in the fiscal year arrangements were made to issue the report on live-stock loadings from Chicago instead of Washington in order to expedite the receipt of the information and to reduce operating costs. It also was found desirable to condense and combine certain reports which are now issued as the "Daily Live Stock and Meat Trade News," more than 20,000 copies of which are being distributed each week. This report includes estimated live-stock receipts at 8 to 10 markets for the day on which the report is released, actual receipts of the previous day at the market from whence the report is issued, the disposition of stock received at this market, and meat trade and live-stock conditions and prices at various markets. Monthly receipts and disposition of live stock at public stockyards are compiled and published and arrangements have been made for more complete and uniform reports from stockyards companies. Reports are now received from 79 stockyards in 71 cities.

Reports concerning the "in" and "out" movement of live stock in grazing and feeding districts were continued, and the live-stock feeders in the districts of Lancaster, Pa., northern Colorado, and the Arkansas Valley of Colorado were furnished current information relative to the movement of live stock from their districts.

Owing to urgent demands the telegraphic reporting service, which was begun during the previous year at Chicago, was extended to include the live-stock markets at Kansas City, Omaha, and East St. Louis. This service consists of a series of telegraphic reports issued at intervals during each market day. The early reports give estimated receipts and the later reports give actual market conditions and prices on all classes of live stock. Through the commercial news departments of telegraph companies, the press associations, and other agencies in addition to the Bureau's branch offices, this service is made available to interested persons both at market centers and country points throughout the United States.

Following the armistice there was a general demand that the monthly survey of stocks of hides and skins which was conducted during the war by the Tanners' Council be continued by this Bureau. In January, 1919, this work was undertaken. In the course of this survey information is collected regarding the supply of domestic and foreign hides and skins on hand and in transit at the close of business on the last day of each month as reported by packers, dealers, importers, and tanners. Summaries of these reports are compiled and distributed.

During the fiscal year 1919 reports were issued each quarter showing the stocks of wool held by manufacturers and dealers throughout the United States. These reports also showed the stocks of wool held by the Government on March 31 and June 30, 1919. More than 98 per cent of the manufacturers and dealers in wool submitted statements from which these reports were compiled.

Monthly reports were made of the consumption of wool, these reports having been prepared from schedules returned by 99 per cent of all of the manufacturers in the United States using wool in the production of their goods. A monthly census of the active and idle wool machinery in the United States was commenced in November, 1918. Detailed reports on wool market prices were issued in May and June, 1919, and during the latter part of the year monthly statements were instituted regarding the amount and condition of the wool imported into the United States monthly under the present import classification.

MARKET NEWS SERVICE ON DAIRY AND POULTRY PRODUCTS.

This news service, which is supervised by Mr. Roy C. Potts, was financed from emergency funds in the fiscal year 1919. Daily market reports on butter, eggs, and cheese were issued from Washington and from the branch offices located at Boston, New York, Philadelphia, Chicago, Fond du Lac, Minneapolis, Denver, San Francisco, and Portland. They were sent to a mailing list composed of the names of over 7,000 persons and firms, each of whom had made specific requests for the reports.

The reports also included information regarding stocks in storage in certain markets daily, the stocks existing in the entire country semimonthly, receipts and current trading stocks at the principal distributing markets, receipts of cheese from factories and stocks in the hands of dealers in the primary markets of Wisconsin, and wholesale prices received by butter and cheese dealers in the wholesale distributing markets and by cheese dealers in the primary markets.

HAY AND FEED REPORTING SERVICE.

During the fiscal year 1918-19 the Hay and Feed Reporting Service, supervised by Mr. C. S. Cole, with field offices at Washington, Atlanta, Fort Worth, Minneapolis, Chicago, Kansas City, Spokane, and San Francisco, published a "Weekly Market Review" of prices, and conditions affecting them, in the principal markets of the country.

This Review was mailed on Saturday of each week to approximately 12,000 producers, dealers, and consumers of hay, feed, and grain who requested it. Special attention was given in this Review to supply of and demand for hay and feed.

On account of a serious emergency caused by drought, offices were established during the year at Bozeman, Mont., and Fort Worth, Tex., through which 5,047 cars of hay and feed were handled. This work aided in saving thousands of cattle from starvation.

SEED REPORTING SERVICE.

During the fiscal year ending June 30, 1919, six branch offices, at Chicago, Kansas City, Minneapolis, Spokane, San Francisco, and

Atlanta, were maintained in connection with this service. Mr. W. A. Wheeler directed this work.

By means of informal inquiries sent to voluntary reporters, growers, shippers, and dealers, and by personal visits, information was obtained and transmitted to Washington, where much of it was assembled and worked into articles or reports for publication in the "Seed Reporter." The most important reports published may be classified as (1) outlook reports, including figures and descriptive matter concerning acreage, yield per acre, quality and prices of field seeds; (2) shipment reports, including stocks in shippers' hands, carry over in growers' hands, shipments during the last season, shipments during the current season, etc.; (3) seed market reports, including trade information—supply, demand, prices, movement, etc., at some of the most important seed-marketing points; and (4) vegetable seed crop condition reports, from the most important seed-producing sections. The publication of these reports made timely information available to the small grower, small shipper, and small dealer which in the past has been in the possession of comparatively few of the largest seedsmen and commercial seed growers. Twelve issues of the "Seed Reporter" were published and mailed monthly to approximately 23,000 growers, shippers, dealers, and other interested persons.

In addition to the reports mentioned, the results of two national seed surveys were published. Besides stocks, receipts, and exports of field and vegetable seeds, these surveys covered sales of certain kinds of field seeds and acreage and production of vegetable seeds. Through the information obtained in these surveys, it has been possible to facilitate the movement of seeds from producer to consumer, and to reduce inflation in seed prices.

CITY MARKET REPORTING SERVICE.

The City Market Reporting Service was conducted during the last fiscal year with emergency funds, under the supervision of Mr. G. V. Branch, in order to furnish a market news service to farmers in the vicinity of large markets who require information of a different character from that furnished to distant carlot shippers, and to keep city consumers informed of market conditions in order that the consumption of abundant products might be facilitated to the advantage of both producers and consumers. Market reports of this sort were issued during the year from 16 offices: Baltimore, Md.; Boston, Mass.; Bridgeport, Conn.; Chicago, Ill.; Cleveland, Ohio; Denver, Colo.; Detroit, Mich.; Hartford and New Haven, Conn.; Philadelphia, Pa.; Providence, R. I.; St. Paul, Minn.; Springfield, Mass.; Waterbury, Conn.; Washington, D. C.; and Worcester, Mass. The offices in St. Louis, Mo., and Lawrence, Mass., where the service had been maintained during the preceding fiscal year, were closed because it was not possible to secure men properly equipped to carry on the work.

The work in the 16 cities named was continued along the lines followed in the preceding year. Reports for growers were enlarged and perfected and were issued each market day, about 30,000 farmers and 600 dealers being reached. The reports were distributed on the market and by mail and in some cases were published in local newspapers.

Reports for consumers were furnished to newspapers which publish them regularly in most cases.

During the fiscal year active cooperation was maintained with local representatives of the Federal Food Administration in the publication of its fair-price lists. On account of the discontinuance of emergency funds this work was closed on June 30, 1919.

EMERGENCY TRAFFIC AND STORAGE ASSISTANCE.

In order to render special assistance during the war, transportation men were sent to heavy producing sections to work in close cooperation with shippers and carriers to avert shortages of cars and ice for refrigeration in transit; to secure heavier and better loading; to procure more efficient service for shippers, and to bring about the best possible utilization of equipment. Although this work was first undertaken during the war, it should be continued in peace times so far as funds are available. Mr. G. C. White directs all work of this character.

During the past year work of this kind was done in the Salt River Valley of Arizona, at Turlock, Calif., at Spokane for the entire Northwest, and at Brawley, Calif., for the Imperial Valley.

FOOD PRODUCTS INSPECTION SERVICE.

FRUITS AND VEGETABLES.

Food products inspection offices were maintained during the past fiscal year in an average of 30 important markets. The service was discontinued in four of the less important markets and new offices were opened in Columbus and Milwaukee. A total of 164 markets were designated as inspection points, most of these being served by inspectors stationed in the branch offices at the important central markets. About 15,000 inspections were made during the year. Mr. W. M. Scott and Mr. C. T. More supervised this work during the past fiscal year.

Amendments to the authority under which the inspection service is conducted, which became effective October 1, 1918, made the service available not only to shippers but to receivers, railroads, and other persons financially interested. Amendments also provided that a fee should be charged for each inspection.

Shippers in all parts of the country are using the service with increasing frequency, and receivers in the markets in which inspectors are located avail themselves of it very generally. The railroads also are making a more general use of its facilities, and in some markets try to secure an inspection certificate on each car or each lot of fruits and vegetables regarding the quality or condition of which there appears to be a question and a likelihood of a future claim. The heaviest demand for inspections has existed in the Eastern and Middle States.

During the first half of the fiscal year close cooperation was maintained with the United States Food Administration. Its Federal, State, and local administrators used the inspection certificates continually since they found them a necessary basis for adjusting a large number of claims between shippers and receivers. Work of a cooperative and advisory nature also was conducted with the Army and

Navy, the inspectors occasionally visiting cantonments and other military posts in order to give advice to camp quartermasters regarding the grading, handling, and inspection of fruits and vegetables. In New York City several men were assigned to inspect supplies of fruits and vegetables for naval vessels and transports. This enabled the Navy Department to effect economies and to obtain supplies of fruits and vegetables of better quality with less waste than otherwise would have been possible.

That the inspection work has been very favorably received by all interests concerned is evidenced by the increasing use which shippers, receivers, and carriers are making of its facilities. Many requests have been received during the year from trade and commercial organizations for the establishment of the service in the cities which they represent, but it has been necessary to decline practically all of these requests because of limited funds.

The Bureau of Markets has had the fullest cooperation of specialists of the Bureau of Plant Industry, who are working to combat fruit and vegetable diseases. They have rendered especially valuable assistance in training market inspectors to identify the more important diseases, and also in preparing valuable hand-colored books illustrating the effects of diseases on fruits and vegetables.

BUTTER.

The butter inspection service, which was instituted during the past year on a small scale, was supervised by Mr. R. C. Potts. Regulations covering the inspection of butter were published in Service and Regulatory Announcements No. 51. This service was conducted in New York, Philadelphia, Chicago, and Minneapolis.

STORAGE REPORTS.

For the greater part of the fiscal year 1919 this work was done under the direction of Mr. C. W. Thompson, assisted by Mr. John O. Bell. The storage reports issued by the Bureau of Markets show the reserve supply of some of the more perishable foodstuffs, and deal for the most part with holdings in cold storage. These reports cover seven classes of foodstuffs, namely, apples, butter, cheese, eggs, frozen and cured meats, frozen poultry, and frozen and cured fish. These classes are subdivided into 50 different items, including 5 kinds of frozen poultry, 7 varieties of cheese, and 25 varieties of fish.

For convenience in tabulating the returns the country is divided into eight geographical sections, as follows: New England, Middle Atlantic, South Atlantic, North Central East, North Central West, South Central, Western North, and Western South. Blank forms are furnished to the 1,400 cold-storage firms in the United States on which to submit their reports. The reports submitted to the Bureau come from the warehousemen and show quantities in storage, regardless of ownership. In addition to showing actual quantities of different commodities in storage on a specified date, certain comparisons are made with reports of other months in order to indicate the relative amount in storage, as compared with previous dates, and the increase or decrease in holdings during the month. Comparison of the holdings of the current month with the same month in the

previous year is made for each geographic section, while comparison concerning the current and preceding month covers the whole United States.

PURCHASE AND DISTRIBUTION OF NITRATE OF SODA.

The purchase and sale of nitrate of soda to farmers was continued in 1919 under authority of section 27 of the food control act, with Mr. J. H. Collins acting directly in charge.

In 1918 nitrate was purchased in Chile and was sold to farmers at \$75.50 per ton of 2,000 pounds. One hundred and twenty thousand tons were purchased, but only 75,000 short tons were received in sufficient time to be distributed during the season of 1918 and about 40,000 tons remained on hand for sale in 1919.

The signing of the armistice and the sudden termination of the war left in the possession of the War Department a large quantity of nitrate which had been purchased and imported for use in manufacturing munitions. The Department of Agriculture arranged to secure about 115,000 tons of this nitrate at salvage rates, and announced a price of \$81 per short ton, f. o. b. shipping point or port. The fact that the 40,000 tons carried over from 1918 were bought at a lower price and sold at \$81 per ton enabled this Department to sell the entire quantity of nitrate distributed during the past fiscal year at only a very slight advance over the War Department's salvage price.

Essentially the same plan of distribution was followed as in 1918. Orders were taken from about 100,000 farmers by county agricultural agents and committees appointed to assist them. As in 1918, nitrate was shipped to the county nitrate distributors on "order notify" bills of lading, with sight drafts attached. These county distributors collected from farmers purchasing the nitrate and also distributed the nitrate on arrival.

Distribution of nitrate to farmers in 38 States was made from 21 storage points. In all cases farmers were given the benefit of the most advantageous freight rates. The first shipments of nitrate went forward during the latter part of January and distribution was not completed until late in June. The bulk of the shipments went forward during the months of March and April.

The smallest application was for one-tenth of a ton; the largest individual application was for 300 tons. A total of nearly 153,000 tons was sold during the year. On the basis of retail prices as reported to the Department, the saving to farmers through the purchase of this nitrate exceeded \$2,000,000 this year.

All applicants received their full quota and practically all shipments went forward in ample time for use during the season.

On June 30, 1919, there remained on hand 1,718.8 short tons of nitrate for which application had not been received. Under the agreement of the purchase this is returnable to the War Department.

REGULATORY WORK.

ENFORCEMENT OF THE UNITED STATES COTTON FUTURES ACT.

The administrative work connected with the enforcement of the cotton futures act is under the general supervision of Mr. D. S.

Murph. The enforcement of the act is carried out under the following projects:

INVESTIGATIONS OF FUTURE AND SPOT MARKETS.

These investigations are directed by Mr. George R. Argo. Securing accurate quotations for different grades of cotton, especially in the case of low grades, has been increasingly difficult during the past season owing to the wide divergence in prices in different sections of the cotton belt. Low-grade cotton has been quoted at the widest discount off Middling, the basis grade, ever known to the cotton trade. Quotations for Good Ordinary have been published by spot exchanges as low as 1,200 points off Middling, and doubtless cotton of this grade has sold at greater discounts at interior points. The possibility of the delivery of future contracts of cotton of this character at differences that were unduly narrow resulted in an abnormal disparity between spots and futures, but the readjustment was rapid as soon as quotations for differences were widened to the approximate selling value of low-grade cottons. Such widening also resulted in creating a broader market for low-grade cotton. Under an amendment to the cotton futures act, by the wheat price guaranty act of March 4, 1919, authority has been granted the Secretary of Agriculture to require reports of purchases and sales of spot cotton in order to secure accurate quotations for the various grades. This information will be especially valuable to the producer when it relates to cotton below Low Middling on account of the untenderability on future exchange contracts of the low grades and the comparative lack of authentic information available to the producer as to their value. It is intended to publish all such information that will be of value to the public.

Representatives of the designated spot markets held a meeting in Memphis in April, 1919, to devise a uniform system of quotations by the spot exchanges. A tentative plan was adopted and submitted to the exchanges for ratification, effective August 1. It appears that substantially all the exchanges have agreed to adopt the plan.

DETERMINATION OF DISPUTES AND CLASSIFICATION OF COTTON FOR DELIVERY ON FUTURE CONTRACTS.

The number of disputes increased materially during the last fiscal year owing to the fact that a large quantity of low-grade cotton was delivered on future contracts. For 1919 a total of 493 disputes were received and passed upon as against 146 in 1918. The total number of bales of cotton involved was 29,303 as against 6,895 in 1918. The amount of money collected for determining the disputes was \$9,066.68 as against \$2,202.30 in 1918. This fund was covered into the Treasury of the United States in accordance with the provisions of the United States cotton futures act.

In accordance with an amendment to the United States cotton futures act by the wheat price guaranty act of March 4, 1919, all cotton to be delivered on future contracts is now classified by the Department of Agriculture, and no further disputes will be heard, except possibly on some old-style contracts outstanding that may be settled by delivery of cotton in fulfillment thereof. Very few old-style contracts, however, are outstanding, and the likelihood of further disputes is remote.

As the amendments to the cotton futures act became effective on March 4, 1919, the date of their enactment, there was some unavoidable delay and inconvenience both to the trade and the Government in the execution of their provisions. The delay in beginning actual classification of cotton at the New York and New Orleans Exchanges occasioned by the necessity for providing an organization and the time required for drafting regulations for this work, however, was not considerable, and only slight inconvenience was caused to the cotton trade with respect to deliveries of cotton on contracts entered into after March 4. Conferences were held with members of the two future exchanges, temporary regulations were adopted, and classification was begun at New Orleans on March 24. Classification for New York began on April 4. Approximately 30,000 bales were classed in New York during April and May for delivery on May contracts and the work was satisfactorily performed with no further delay to the trade. Final regulations governing the classification of cotton for future delivery under section 5 of the cotton futures act were adopted by the Secretary on May 20, 1919, and became effective immediately.

Cotton classed to June 30 in New York amounted to 37,354 bales; in New Orleans, 6,741 bales.

Owing to the congestion at the warehouses in New Orleans, delivery of spot cotton on future contracts has been considerably less than normal.

PREPARATION AND DISTRIBUTION OF OFFICIAL COTTON STANDARDS.

During the greater part of the fiscal year this work was supervised by Mr. Fred Taylor, and after his resignation by Mr. D. E. Earle.

Since the standards for grade of upland cotton were promulgated in 1914, and up to June 30, 1919, 1,145 full white and colored sets and 296 fractional colored sets were sold. On August 1, 1918, the price of each box of all grade standards was advanced from \$2.50 to \$5 on account of increased cost of labor, material, and transportation. Every important cotton exchange and spot market in the United States has adopted these standards and uses them as a basis of daily quotations.

Official cotton standards for American-Egyptian and Sea Island cottons and standards for length of staple were established and promulgated effective October 25, 1918. Thirty-four full sets and one fractional set of American-Egyptian grade standards, four full sets of American Sea Island standards, and 72 sets of the standards for length of staple have been sold to the trade since their promulgation. A method of pulling staple has been devised and recommended for adoption by the trade.

During the fiscal year ending June 30, 1919, \$37,840.71 was covered into the Treasury as miscellaneous receipts—\$31,987.71 from the sale of miscellaneous and rejected cotton and \$5,853 from the sale and revision of copies of the standards.

ENFORCEMENT OF THE UNITED STATES GRAIN STANDARDS ACT.

The enforcement of the United States grain standards act was carried out in its third year under the direction of Mr. George Livingston.

On July 15, 1918, the standards for both shelled corn and wheat were revised. The revision in the case of the corn standards was slight, while the changes in the wheat grades were greater. As a result of these changes the percentage of the 1918 crop of wheat which fell into the higher grades was considerably higher than the percentage of the 1917 crop so falling. Available data show also that a larger percentage of the 1917 crop, which was graded by the original standards, fell into the top grades than would have been true had former diverse State and local standards been applied. The fixed price for wheat, which was based upon the Federal grades, resulted in the use of these grades in practically all sales of wheat made throughout the United States during this period, and consequently close cooperation was maintained with the Grain Corporation of the Food Administration.

On June 16, 1919, the Federal standards for oats were made effective and seem to be giving general satisfaction. These standards had been discussed with producers, grain shippers, elevators, warehousemen, and other members of the trade prior to their publication and public hearings also were held. The grades also were tried out experimentally for several weeks before they were finally put into effect.

As the result of conferences with representative members of the grain trade a committee was selected late in the fiscal year to investigate conditions at inspection points east of the Rocky Mountains. This committee was selected by the grain trade and was composed of representatives of the Grain Dealers' National Association, the National Council of Farmers' Cooperative Associations, the Council of Grain Exchanges, the Millers' National Federation, and the Car Service Section of the Railroad Administration. All phases of the work performed in enforcing the grain standards act were considered, and the report of the committee shows that the trade and most of the inspection departments consider the Federal standards satisfactory when uniform methods and equipment are used, and that where proper cooperation was maintained between the various agencies concerned the enforcement of the act was proceeding in an entirely satisfactory manner. The committee recommended that an amendment to the grain standards act should be made in order to permit the entertaining of appeals on the grading of intrastate shipments by licensed inspectors and that grain samplers should be licensed under the act in the same manner that inspectors are licensed.

It became evident at the beginning of the fiscal year that closer contact with the actual work of supervision, inspection, and grading was necessary, and in January a field headquarters office was established at Chicago, Ill., within one night's travel of most of the great grain markets of the country.

Chicago also was made the headquarters of the board established during the past fiscal year to review the grade determinations made in the 35 branch offices. Since its organization during the past fiscal year, this board has reviewed 3,837 samples submitted by the various supervision offices and considered appeals from shippers who were dissatisfied with the decisions made by supervisors on appeals from inspections by licensed inspectors. This board also has reviewed, analyzed, and tabulated its findings with regard to 1,500 samples of oats from various supervision offices, and has prepared 185 type trays

showing the effect on oats of damage and heat damage, the various classes of oats, and the minimum color requirements for oat grades. These trays are used as guides in grading oats.

In order to supervise more intimately the work of inspectors and promote uniformity and efficiency in the inspection work, a total of 53,149 grain samples have been examined in the various branch offices during the past fiscal year.

Twenty-six demonstrations showing the methods of grading grain and the proper use of grain-grading apparatus were made at State and county fairs in Minnesota, Montana, Iowa, North Dakota, Texas, Ohio, Nebraska, Washington, and Kansas, and 17 demonstrations were made at meetings of grain dealers' associations in Ohio, Texas, Kansas, Kentucky, North Dakota, Arkansas, Iowa, Missouri, Illinois, Colorado, Minnesota, and Georgia. Thirteen grain-grading schools were conducted in cooperation with the agricultural colleges in Idaho, Ohio, Missouri, Iowa, Oregon, and Michigan. This work has been productive of highly beneficial results and has been well received by producers and the trade.

Investigations were made of 58 cases of apparent violations of section 4 of the grain standards act regarding shipment of grain without inspection. Four of these cases have been referred by the Solicitor of the Department to the Attorney General for prosecution and another is now being prepared for transmission. Twenty cases involving misgrading of grain under the provisions of section 5, covering representations of grade other than those shown on inspection certificates, have been investigated, and in three cases the findings of the Secretary of Agriculture have been published. Some shippers have voluntarily restored large sums of money to buyers where violations of the act have been brought to light. Thirteen cases, involving violations of section 7, owing to certifications by persons not holding licenses, have been investigated as well as 11 cases involving charges against licensed inspectors under the same section. One case involving violation of section 10 also has been investigated.

Questions involving certification of cargo shipments of grain on the Great Lakes and the use of private brands by large shippers and exporters have been investigated to determine whether violations of the act are involved.

During the year 446 licenses were issued, two licenses were revoked, and 125 examinations were held to determine the eligibility of persons desiring to secure licenses. Twenty applicants for licenses were found unqualified.

During the year 6,651 appeals were filed through the supervision offices. The grades assigned by the licensed inspectors were found to be correct in 3,295 cases, while 3,293 cases showed the inspector to be in error. Sixty-three appeals were dismissed.

Nine disputes, representing controversy as to the grade of grain shipped between noninspection points, were handled during the year.

ADMINISTRATION OF UNITED STATES WAREHOUSE ACT.

The administration of this act is under the supervision of Messrs. D. S. Murph and R. L. Nixon. Recent amendments which were contained in the appropriation bill for the current year should do much to popularize the act, and it is hoped that warehousemen will

take out licenses in increasingly large numbers now that certain obstacles have been removed. The State of North Carolina recently has adopted a law providing for a State system of licensed warehouses, and close cooperation will be maintained between this Bureau and the State officials who direct this work.

Licenses have been issued to five cotton warehousemen and nine cotton weighers and classifiers during the fiscal year, and applications are on file from 28 additional warehousemen. As soon as the necessary bonds are supplied, licenses will be issued to these applicants.

Substantial reductions in the cost of insuring licensed warehouses have been secured from rating bureaus in the South.

Approval of forms of receipts to be used under the regulations has been secured from the Federal Farm Loan Board and steps have been taken to secure like approval from the Federal Reserve Board.

Proposed regulations for grain warehouses have been issued and public hearings have been held. These regulations are now being prepared in final form and the Department will be ready to consider applications from grain warehousemen in the near future.

Regulations for tobacco and wool warehouses are in the course of preparation.

ENFORCEMENT OF THE STANDARD CONTAINER ACT.

During the past year the enforcement of the standard container act was supervised by Messrs. W. M. Scott and C. T. More, assisted by Mr. F. P. Downing.

On account of the cooperation of package manufacturers, the work connected with the enforcement of the United States container act has been largely educational and corrective, one prosecution only having been brought against a manufacturer for violation of this law. In this case the defendant pleaded guilty. Shippers, manufacturers, the wholesale trade, and retailers have expressed great satisfaction with the results of the operation of this legislation. It has served to remove some of the unnecessary differences in size of packages and simplifies the marketing problem to that extent. Manufacturing plants in all parts of the country have been visited and their products have been tested. During the past year particular attention has been given to the packages manufactured in the Rocky Mountain and Pacific Coast States.

SUPERVISION OF STOCKYARDS AND LIVE-STOCK DEALERS.

The supervision of licensees operating stockyards or dealing in or handling live stock in or in connection with stockyards, as authorized by the President's proclamation of June 18, 1918, is conducted by the Bureau of Markets under the direction of the Secretary of Agriculture. Mr. Louis D. Hall is directly in charge of this work. A total of 2,803 licenses were in effect at the end of the past fiscal year. General regulations governing licensees were issued July 26, 1918, as Circular No. 116 of the office of the Secretary of Agriculture. These regulations were supplemented on September 24, 1918, in accordance with a proclamation of the President dated September 6, 1918, which extended the authority to include the live-stock buying activities of packers and the handling of dead stock by rendering concerns.

A corps of market supervisors was organized as rapidly as practicable and stationed in 26 important live-stock markets. One hun-

dred and twenty-one licensed stockyards were placed under the supervision of the officers at the 26 central markets in whose respective districts they were located.

Complaints regarding various alleged violations of the regulations have been heard and acted upon, and other specific matters requiring adjustment by the local supervisors have been considered. The following instances afford an illustration of the numerous and varied cases that have been dealt with. Adequate facilities and service have been provided at a number of poorly equipped stockyards; new scales, pens, chutes, and other equipment have been put in; the cleaning of dirty pens has been made obligatory; arrangements for loading, unloading, and moving stock through stockyards have been improved and additional yardmen have been employed; terminal railroads have been required to furnish faster service, thus eliminating a large amount of delay and shrinkage; unsuitable feed has been rejected; more accurate checks on weights of feed have been provided, and feed charges have been reduced in some cases at the instance of the market supervisors.

The books of commission firms and stockyard companies at a number of the large markets were examined for the purpose of determining whether increased charges for handling live stock were justified under the regulations, and a number of public hearings on this subject were held. The examination of these books disclosed several instances of overcharges on feed accounts. One licensee made restitution through the Bureau of Markets of more than \$20,000 to his consignors in amounts ranging from a few cents to more than \$900. Action in several other cases is pending; these involve overcharges aggregating approximately \$40,000. One commission firm has been obliged to restore to consignors amounts aggregating over \$18,000 which it wrongfully withheld when remitting for sales, and its license has been surrendered. The license of a firm found guilty of stealing live stock has been revoked. Some of the live-stock exchanges have passed new rules forbidding certain practices which are contrary to the spirit of the regulations, such as the use by commission firms of "cripple buyers" as yardmen, and the giving of tips to stockyard employees for special privileges in yarding stock. Partiality in the assignment to commission men and traders of pens and weighing arrangements has been eliminated at some of the important markets.

Besides the numerous specific cases which have been dealt with, many irregular and injurious practices have been eliminated voluntarily by the companies concerned in order to comply with the regulations. The mere presence of the supervisors at the markets has had a salutary effect. Numerous testimonials have been received regarding the wholesome effect of this service and the improvement of business practices and conditions at the stockyards.

A comprehensive investigation of the market classification of live stock was made to assist in establishing uniform standards on which to base price quotations at the various markets. The investigation resulted in the adoption of a tentative classification for the guidance of the supervisors and reporters at licensed stockyards. Preliminary arrangements were effected for recording and reporting live-stock and meat shipments from some of the principal market centers.

COMPLETION OF THE WORK OF THE DOMESTIC WOOL SECTION OF THE WAR INDUSTRIES BOARD.

By Executive order dated December 31, 1918, the work of the wool division of the War Industries Board was transferred to the Bureau of Markets and the sum of \$10,000 was allotted by that board for the continuation of its work until July 1, 1919. A total force of 3 technical men and 14 clerical employees has been engaged in auditing accounts received from dealers and in collecting and distributing the excess profits made by these dealers. In the course of this work, reports have been requested from 3,500 licensed country dealers and from 200 dealers who, it was discovered, had handled 1918 wool without permits. After the publication of Service and Regulatory Announcements No. 50, entitled "Government Control of the Wool Clip of 1918—Review of Regulations and Interpretations Thereof," reports of the year's transactions were requested from about 180 distributing center dealers. An audit of the accounts of country dealers shows that only one out of every six or seven made profits in excess of the amount permitted by Government regulation. All sums collected as excess profits will be returned to the proper parties.

PUBLICATIONS DURING THE YEAR.

DEPARTMENT BULLETINS.

- 690. Marketing Practices of Wisconsin and Minnesota Creameries. By R. C. Potts.
- 709. Reports of Storage Holdings of Certain Foods Products. By J. O. Bell and I. C. Franklin.
- 734. Nematode Galls as a Factor in the Marketing and Milling of Wheat. By D. A. Coleman and S. A. Regan.
- 764. Factors Influencing the Carrying Qualities of American Export Corn. By E. G. Boerner.
- 770. Motor Transportation for Rural Districts. By J. H. Collins.
- 776. Cold Storage Reports, Season 1917-1918. By John O. Bell.
- 786. Prevailing Plans and Practices of Farmers' Mutual Fire Insurance Companies. By V. N. Valgren.
- 788. Moisture in Wheat and Mill Products. By J. H. Shollenberger.
- 789. Notes on Grain Pressure in Storage Bins. By W. J. Larkin. (In press.)
- 792. Reports of Storage Holdings of Certain Food Products During 1918. By John O. Bell. (In press.)
- 801. Construction and Fire Protection of Cotton Warehouses. By J. M. Workman. (In press.)
- 811. A System of Bookkeeping for Grain Elevators. By B. B. Mason, Frank Robota and A. J. Swarthout. (In press.)

FARMERS BULLETINS.

- 1032. Operating a Cooperative Motor Truck Route. By H. S. Yohe.
- 1050. Handling and Loading Southern New Potatoes. By A. M. Grimes.
- 1055. Country Hides and Skins: Skinning, Curing and Marketing. By C. V. Whalin, F. P. Veitch and R. W. Hickman (in cooperation with Bureaus of Chemistry and Animal Industry.) (In press.)

YEARBOOK SEPARATES.

- 763. Cotton Warehousing—Benefits of an Adequate System. By R. L. Newton and J. M. Workman.
- 764. Cattle Loans and Their Value to Investors. By C. S. Cole.
- 766. The Farmer and the Federal Grain Supervision. By R. H. Brown.
- 768. Following the Produce Markets. By G. B. Fiske.
- 775. Some Effects of the War Upon the Seed Industry of the United States. By W. A. Wheeler and G. C. Edler.
- 788. Government Market Reports on Live Stock and Meats. By James Atkinson.

CIRCULARS OF THE OFFICE OF THE SECRETARY.

116. General Regulations Governing Licensees Operating Stockyards, or Handling or Dealing in Live Stock in or in Connection with Stockyards, issued July 26, 1919. Also, Amendment No. 1.
120. Rules and Regulations of the Secretary of Agriculture under the Food Products Inspection Law of October 1, 1918.
137. Regulations of the Secretary of Agriculture under Section 5 of the United States Cotton Futures Act, amended March 4, 1919.

DOCUMENTS.

12. Grain Driers in the United States.
13. Heavy Loading of Freight Cars in the Transportation of Northwestern Apples. By H. J. Ramsey.
14. Loading American Grapes. By H. S. Bird and A. M. Grimes.
15. Standards for Milled Rice. Prepared by the United States Department of Agriculture and adopted by the United States Food Administration.
16. Instructions for the Sampling, Handling, Analyzing, and Grading of Samples of Milled Rice. By F. B. Wise.
17. Lining and Loading Cars of Potatoes for Protection from Cold. By H. S. Bird and A. M. Grimes.

SERVICE AND REGULATORY ANNOUNCEMENTS.

- 37-40, 42, 44-49, 52, 54-56. (Under United States grain standards act.)
41. (Under United States cotton futures act.)
53. (Under the United States warehouse act.)
43. Sale of Nitrate of Soda to Farmers by the United States Government, 1919.
- 43A. Sale of Nitrate of Soda to Farmers of the Pacific Coast and Great Basin by the United States Government, 1919.
50. Government Control of the Wool Clip of 1918.
51. The Inspection of Butter under the Food Products Law.

DEPARTMENT CIRCULAR.

1. Suggestions for the Marketing of Cottage Cheese. By D. L. James. (In press.)

FOOD SURVEYS.

Vol. 1, Nos. 10-14; Vol. 2, Nos. 1-27.

SEED REPORTER.

Vol. 2, Nos. 1-12.

MISCELLANEOUS.

U. S. G. S. A. 90 Handbook, Official Grain Standards for Wheat and Shelled Corn.

After Hoboken? (Booklet for use of soldiers.)

Pure-bred Live Stock of the United States of America. (Issued in Spanish and Portuguese for distribution in South America.)

PERIODICAL REPORTS.

The bureau also issues periodical reports in mimeographed form (daily, weekly, semimonthly, monthly, etc.), covering various conditions affecting the marketing of fruit, vegetables, live stock, meat, grain, seeds, hay, dairy products, wool, animal hair, hides, and skins, as well as the cold-storage holdings of apples, meats, eggs, poultry, and dairy products. A weekly report on foreign marketing conditions is issued. These reports are described in some detail in the foregoing pages.



REPORT OF THE CHIEF OF THE OFFICE OF FARM MANAGEMENT.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF FARM MANAGEMENT,
Washington, D. C., August 20, 1919.

SIR: I am submitting herewith the annual report of the Office of Farm Management for the fiscal year ended June 30, 1919.

Respectfully,

H. C. TAYLOR, *Chief.*

HON. D. F. HOUSTON,
Secretary of Agriculture.

Reorganization of the Office of Farm Management in accordance with a plan determined upon in a conference on reorganization held early in the present calendar year has now progressed so far that work is being inaugurated along the new lines of investigation provided for in the revised outline of projects. The office enters the new fiscal year with the preliminary work in this regard well in hand.

Under the plan adopted, the field of research work covered by the office has been divided into seven sections, as follows:

1. Cost of production.
2. Farm organization.
3. Farm financial relations.
4. Farm labor.
5. Agricultural history and geography.
6. Land economics (including land ownership and tenancy).
7. Farm life studies.

Cost of production studies along the lines suggested by a committee appointed by the Secretary to make recommendations in this regard have begun under the direction of Mr. F. W. Peck. Mr. Peck is also directing, temporarily, the work in farm organization. Dr. L. C. Gray, in charge of land economics, has outlined a series of inquiries in land ownership and tenancy, land settlement and colonization, and land policies. Farm life studies have been inaugurated under the direction of Dr. C. J. Galpin. Of the remaining sections, Agricultural History and Geography is identical with the old section of History and Distribution of Farm Enterprises; that of Farm Financial Relations is being established by transfer of existing groups from the Bureau of Markets; and that of Farm Labor remains to be organized.

Owing to the fact that practically all the research work done during the past year was done under the old plan of organization, the following detailed report of progress, for the most part, is arranged according to the old classification.

COST OF PRODUCTION.

Eight hundred and sixty-five cotton-enterprise records, together with the necessary farm organization data, were obtained from cotton growers in four of the southern States during the months of May and June, 1919. These records were distributed as follows: 162 representing two districts in Texas; 269 from three areas in Alabama; 254 from three sections in Georgia; and 180 from two areas in South Carolina. This material embraces staple factors of cotton and will allow the estimations of cost by using current prices.

Cooperative costs of production studies of the tobacco crop were instituted in May with the Kentucky Experiment Station. This enterprise study entails the cooperation with 160 representative tobacco growers in which the tobacco enterprise is studied in detail and in relation to the entire farm business.

Arrangements are being made with a number of the States looking toward cost accounting investigations to begin with the new farm year of 1920. A cost of tractor operation and farm organization study was arranged with the Ohio Experiment Station, the work in the field to begin July 10.

Tentative plans have been laid for making studies in the cost of producing wheat and sugar beets, and for special investigations in live-stock economic problems.

FARM BUSINESS ANALYSIS STUDIES.

Studies of the business side of farming and of factors affecting the profitable organization of farms have made substantial progress during the year. An additional year's work on continuing surveys of farms has been inaugurated in the following areas:

Seventh year of the study of farms in a representative area of the hill land drained by the Ohio River (Washington County, Ohio).

Sixth year of the study of farms in a representative area of general farming in the Corn Belt (Clinton County, Ind.).

Third year of the study of farms in a representative area of fruit and general farming in the Shenandoah Valley (Frederick County, Va.).

Second year of the study of farms in a representative area of truck farming in Florida.

Second year of the study of farms in a representative area of the citrus fruit industry in Florida.

Second year of the study of small farms in the vicinity of Columbus and Cleveland, Ohio, and Indianapolis, Ind.

In cooperation with the Wisconsin College of Agriculture, the sixth year of the study of farms in Dane County, Wis.

These studies show in more or less concrete fashion the profits in farming over a period of years in a given area or for a certain type of farming. They give light on the effect, not only of those factors over which the farmer exerts more or less control, but also something regarding the effect of many factors over which he has little or no control.

In connection with these studies the results of the five-year study in the hill-land section of the Ohio River have been published as Department Bulletin 716, "A Five-Year Farm Management Survey in Palmer Township, Washington County, Ohio, 1912-1916." Department Bulletin 694, "A Study of Farm Management Problems in

Lenawee County, Michigan," covering the results obtained in a typical dairy farming area in southern Michigan, was also issued during the year.

CROP ECONOMICS.

During the year material was collected in western New York with special reference to labor-saving devices in handling the apple crop. Supplementary data were also secured in connection with a survey which was made in the apple-growing districts of western New York about two years ago. This practically completes the list of reports relating to the cost factors in the production of apples under various conditions in the United States. No new work was started on apples during the year.

Progress was made in bringing to completion a part of the investigational work on hay. In 1918 records were taken in the alfalfa and Johnson grass districts of Alabama and Mississippi. Two descriptive bulletins, namely, Farmers' Bulletin 1009, entitled "Hay Stackers," and Farmers' Bulletin 1049, entitled "Baling Hay," were published during the year.

Prior to 1918 a large number of estimates were obtained from farmers on the production of corn silage, particularly with reference to the effect of the degree of maturity on yields, shrinkage and wastage in storage, and the relative costs of different methods of handling this crop. A careful analysis has been made of the information contained in these records and comprehensive reports have been prepared summarizing the results.

Two hundred and eighty-five sugar-beet enterprise records were obtained in the irrigated districts of Colorado during the summer of 1918. These records were concerned chiefly with the labor requirements of such crops as alfalfa, barley, wheat, oats, beans, corn, etc., which are grown in the beet-producing sections. Three publications on sugar beets were issued, namely, Department Bulletin 748, "Farm Practice in Growing Sugar Beets in Michigan and Ohio," Department Bulletin 760, "Farm Practice in Growing Sugar Beets in Three California Districts," and Farmers' Bulletin 1042, "Saving Man Labor in Sugar Beet Fields."

LIVE-STOCK ECONOMICS.

In the field of live-stock economics studies of the costs of growing and of fattening beef cattle, which covered a number of the large western ranches and selected areas in the corn-belt region, were undertaken in cooperation with the Federal Trade Commission, and the data obtained have been worked up and submitted to the commission.

Data are now being gathered on the cost of fattening beef cattle for the market. Cooperative relations have been established with the Bureau of Animal Industry, and financial cooperative relations have been arranged with Indiana and Illinois for the carrying on of this investigation.

FARM BOOKKEEPING AND COST ACCOUNTING.

Cooperative investigations in cost accounting on individual farms and studies of systems of bookkeeping and cost accounting in use by farmers and agricultural interests in general have been continued.

Work done in the field has consisted of visits to cooperating farmers for the purpose of making inventories, measuring crop areas, and securing other data necessary for the completion of records, and conferences with county agents and farmers seeking advice and assistance in farm accounting work. Current office work has included the posting, tabulating, and summarizing of cooperators' records, and the handling of a considerable mass of correspondence and personal inquiry from individuals interested in farm accounts or cost accounting.

In addition to routine work, a special study has been made in connection with the farm labor problem created by the war. In this connection, labor requirement data, by months, for each crop or other farm enterprise and for the farm as a whole, were tabulated for 69 farm years, covering representative farms in four agricultural regions.

AGRICULTURAL HISTORY AND GEOGRAPHY.

Work on the Atlas of American Agriculture, which was somewhat delayed by the war, has made considerable progress during recent months. Four sections are now awaiting publication, and work is in progress on eight more. The sections entitled "Frost and the Growing Season" and "Cotton" were issued during the year.

In addition to routine work on the Atlas, much time has been devoted to studying the agriculture of certain foreign countries involved in the war, for the purpose of supplying information to the American representatives at the Peace Conference. The following maps were prepared:

Austria-Hungary: Forests; crops and classes of live stock.

The Balkan countries: Crops and classes of live stock.

Turkey: Forests; crops and classes of live stock; precipitation.

Africa: Commercial crops and live stock of the former German Colonies. Also, in cooperation with the Weather Bureau, precipitation charts of the continent.

Some progress has been made in a similar study of the agriculture of South America. Data have been compiled on Argentina, Chile, Uruguay, and Brazil.

Although these maps and accompanying reports have been prepared primarily with the object of affording information to the Commission to Negotiate Peace, the data and copies of the maps which have been retained will be of great value in preparing the various sections of the Atlas.

Attention has also been given to problems of reconstruction, particularly to studies of the location, extent, and character of potentially arable land in the United States.

TENANCY AND FARM-LABOR PROBLEMS.

On account of the urgent demand for practical work on the subject of farm labor, a part or all of the time of the men engaged on tenancy projects of the office was withdrawn from that subject and

devoted to farm labor or some other related matters. On this account it was impossible to do much field work during the year. Material on the subject of renting land devoted to sugar beets, on stability of tenure of the farm operator, and on methods of renting farms in the wheat belt of the Central West was worked up. Some work was also done on data relating to the general subject of renting farms, the renting of land devoted to small grains, the renting of dairy farms, systems of renting by stock shares, and the rent relations existing between landlord and tenant on a New York farm. Additions were made to the large collection of leases in possession of the office, and the files of these were indexed to make them more readily available.

The farm-labor operations were conducted along the lines which were pursued during the previous fiscal year. Farm-help specialists were maintained in practically every State. These men worked in co-operation with the extension divisions of the agricultural colleges, particularly the county agents, and also with the State departments of agriculture, State departments of labor, and other State organizations concerned with the labor problem, and finally with the United States Employment Service and other employment offices. The farm-help specialists took an active part in organizing local farm-labor business.

Attention was chiefly devoted to the problem of making labor more efficient on the farms. This involved the encouragement of the cooperative exchange of labor among farmers, the study of wages as related to farm prices, the provision of better housing and living conditions for laborers, the use of gasoline power, labor-saving devices, and the development of a better spirit of cooperation between the farmer and the city business man in solving the annual problem of seasonal farm-labor requirements.

Active cooperation was also maintained with the War Department, particularly with the morale branch of the General Staff. In this work the office maintained representatives at 11 demobilization camps for the purpose of furnishing information regarding agricultural opportunities and particularly regarding openings for employment on farms to all returning soldiers who were interested in agriculture.

FARM EQUIPMENT.

The work done during the year with reference to farm equipment has been largely concerned with the use of power machinery and with the relations between mechanical power and horse power. Three new studies were made:

1. A study of the displacement of horses by tractors and the cost of operating tractors on about 200 corn-belt farms was made during the summer of 1918.
2. A preliminary economic study of the use of motor trucks on farms was made in sections around Kansas City, Omaha, and Indianapolis, with the intention of obtaining, as soon as possible, detailed information on motor-truck operations from a large number of farms in all parts of the country.
3. A study of the duty of farm implements and crews and the costs of using farm implements in central Illinois.

The section cooperated actively with the Office of Farm Equipment Control.

The following publications on farm equipment were issued during the year:

Farmers' Bulletin 992, "The Use of Machinery for Cutting Corn"; Farmers' Bulletin 1004, "The Gas Tractor in Eastern Farming"; Farmers' Bulletin 1013, "Practical Hints on Running a Gas Engine"; Farmers' Bulletin 1023, "Machinery for Cutting Firewood"; Farmers' Bulletin 1035, "The Farm Tractor in the Dakotas"; and Farmers' Bulletin 1045, "Laying Out Fields for Tractor Plowing."

FARM-MANAGEMENT DEMONSTRATION WORK IN SOUTHERN STATES.

This project has proceeded with the instruction of farmers in the importance of the known economic facts and principles that underlie successful farming and in assisting them in so adjusting their practices and management as to comply more nearly, if possible, with these facts and principles.

This work has been conducted through meetings, correspondence, and personal visits to farmers, by farm demonstrations, by farm records, and by inquiry into the practices of individual farmers and communities of farmers. About 1,000 farmers have been reached personally by the farm-management specialists and many others indirectly.

The following bulletins have been published: Farmers' Bulletin 1000, "Crop Systems for Arkansas"; Farmers' Bulletin 1015, "Producing Family and Farm Supplies on the Cotton Farm."

The Alabama Agricultural and Mechanical College has accepted for publication an extension bulletin on "Man Labor on Southern Crops."

Numerous articles have been prepared by the specialists for the local press in the various States.

REPORT OF THE SOLICITOR.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF SOLICITOR,
Washington, D. C., October 13, 1919.

SIR: I submit herewith report of the work of the Office of the Solicitor for the fiscal year ended June 30, 1919.

WM. M. WILLIAMS,
Solicitor.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

SUMMARY.

During the fiscal year Congress enacted several statutes which substantially increased the work of the department and consequently of this office. The first of these was the act of July 3, 1918, known as the "Migratory bird treaty act," to carry into effect the treaty with Great Britain for the protection of migratory birds in the United States and Canada. The administration of the act is committed to the Secretary of Agriculture. By section 5 of the Post Office appropriation act of February 28, 1919, the scope of the term "rural post roads," as used in section 2 of the Federal aid road act of July 11, 1916, was extended to include several additional classes of roads, and by section 6 of this act \$200,000,000, additional to the appropriation made by the Federal aid road act, were appropriated for the purposes of that act as amended. Section 8 of the Post Office appropriation act also made an additional appropriation of \$9,000,000 for cooperative or independent department construction of roads in national forests in States, Territories, and insular possessions. The appropriation of \$500,000 in the Agricultural appropriation act for the fiscal year 1919, for investigation, control, and eradication of tuberculosis of animals contained a proviso that if, in the opinion of the Secretary of Agriculture, it should be necessary to destroy tuberculous animals and to compensate the owners for the loss thereof, he might expend so much of the appropriation as he should determine for such compensation in cooperation with States, counties, or municipalities making similar provisions for compensation.

Various activities of the department relating directly to the war were continued during the fiscal year. The office assisted in the drafting of the act of March 4, 1919, commonly known as the wheat guaranty law, and the report of the Committee of the House of Representatives thereon. Assistance was given in the preparation of an amendment to the President's proclamation licensing stockyard operators and others handling or dealing in live stock in connection

with stockyards, and the office prepared, in whole or in part, the schedules to be used in food, fertilizer, farm implement, and seed surveys. Assistance was rendered in the preparation of various forms for administration of the proclamations requiring the licensing of persons, companies, and corporations engaged in the operation of stockyards, and the manufacture and sale of fertilizers and farm implements. Assistance was also given in developing a plan for the allotment, sale, and delivery of approximately 140,000 tons of nitrate of soda to farmers, and in the preparation of a circular of information, application forms, and letters of instruction to bankers and distributors. One hundred and fifteen nitrate shortage claims were reviewed to determine the liability of the Government therefor. Assistance was given in hearings and conferences and in the drafting of correspondence with fertilizer manufacturers, through which they were induced to permit the farmers to purchase fertilizers in lots of 30 tons or more for the same price paid by dealers, and aid was given at conferences and in correspondence in securing reductions of approximately 30 per cent in the prices of mixed fertilizers for the fall season of 1919. Representatives of the office conducted various hearings throughout the country and otherwise assisted in the proceedings relative to live-stock commission and yardage rates and other charges for service at stockyards, the vaccination of stock hogs, complaints submitted by the Farmers' Union Livestock Commission against the Omaha Livestock Exchange, and complaints against live-stock commission companies for overcharges in feed bills, etc.

Under the Saulsbury resolution the office advised, and handled in court, the cases of a number of department employees threatened with eviction from their premises.

Aside from the war work, partly mentioned above, under your direction, upon requests of committees or Members of Congress, the office prepared or assisted in the preparation of several bills of a comprehensive nature, including bills to regulate the packing industry (S. 2199, 66th Congress), interstate commerce in fertilizers (H. R. 15327, 65th Congress), interstate commerce in commercial feeds (H. R. 16224, 65th Congress), the grading of fruits and vegetables (H. R. 5309, 66th Congress), the promotion of rural health (H. R. 13342, 65th Congress), and the standardization of hampers and round stave baskets. Amendments of the United States cotton futures act, the United States warehouse act, and the United States grain standard act were also drawn, of which the first two were enacted. Advice and suggestions were given with reference to a uniform State credit bill, and a bill to provide for State farmers mutual insurance was drafted. A weights and measures bill for the District of Columbia and a proposed New Jersey cooperative banking law were reviewed and changes suggested. Proposed grain grading, inspection, and marketing laws of Colorado, Idaho, North Dakota, Oklahoma, South Dakota, Washington, and Wisconsin were considered and comments made thereon. A bill drawn for introduction in the Tennessee Legislature, granting to the United States the State's title to land in areas proposed to be acquired by the Government under the Weeks forestry law, was enacted. Numerous special items for inclusion in the agricultural appropriation bill were drafted or reviewed, including an amendment of the plant-quarantine law to regulate movement of nursery stock and other plants and plant products

into the District of Columbia; amendment of the meat-inspection law to cover horse meat; amendment of the act of March 3, 1917, relating to the cooperative activities of the department; a provision for the eradication of tuberculosis in animals and authorizing the Secretary of Agriculture to pay part of the value of animals destroyed in co-operation with the States in the eradication of tuberculosis; and an item authorizing payment of rewards for evidence of fire trespasses on the National Forests.

A substantial part of the time of the office was consumed in appearance of its members before committees of Congress in hearings held on various bills affecting in whole or in part the work of the department.

The office prepared, or assisted in the preparation of, the department's reports upon various bills referred by committees of Congress having them in charge. Among the bills reported upon were 56 affecting the National Forests, one prohibiting the sale of game in the District of Columbia, another authorizing the establishment of game refuges in the National Forests, another authorizing the acceptance by the Secretary of Agriculture of gifts of lands to be devoted to the conservation of wild life, and one to amend the Alaska game law. The office was frequently called upon during the year to hold or participate in hearings and conferences in Washington and elsewhere relative to the various activities of the department. Among the hearings held, additional to those relating to war emergency measures heretofore mentioned, were 14 regarding disparities between quotations of the "future" and "spot" exchanges and utilization of low-grade cotton; disputes between buyer and seller under the cotton futures act; in 15 markets on the oat standards; at Minneapolis, Minn., and Fargo, N. Dak., relative to the grain-grading law of North Dakota; 16 on the proposed grain warehouse regulations; on the proposed revocation of the license of a fertilizer manufacturer in Massachusetts; on terms and methods of sale of fertilizers; and on the operation of stockyards. Conferences were attended with the Bureau of Markets and the Railroad Administration relative to the loading of grain cars; with the Railroad Administration relative to licensing as inspectors railroad elevator employees and to demurrage charges on grain cars; with the trade and others interested relative to various grain standards problems; with trade representatives relative to proposed regulations for grain warehouses; with the Bureau of Markets, the War Finance Corporation, the Farm Loan Board, State Boards of Agriculture, and insurance rating bureaus relative to the administration of the warehouse act; with manufacturers, producers, and sellers relative to the terms and methods of sale of fertilizers; with various operators and patrons relative to the operation of stockyards; with various State agencies relative to cooperative work with the Department of Agriculture involving marketing and similar activities; and with the United States game wardens relative to the administration and enforcement of the migratory bird treaty act and the Lacey Act.

The office prepared, or assisted in the preparation of, numerous regulations, orders, forms, specifications, and schedules required in the administration of various statutes committed to the department for execution. Some of the more important of these were regulations to carry into effect the migratory bird treaty act; regulations

under the virus, serum, and toxin law; regulations governing compensation to owners of tuberculous animals destroyed; amendments of regulations under the Alaska game law; amendments of the meat-inspection regulations; amendments of regulations for the administration of cotton warehouses; regulations governing inspection and handling of export animals, governing interstate movement of live stock, under the plant quarantine act, under the vocational rehabilitation act, to carry into effect the food products inspection law, governing inspection of horse meat, governing entry of pure-bred animals, under section 5 of the cotton futures act as amended; amendment of regulations under the grain standards act; and numerous amendments of the administrative and fiscal regulations of the department. Among the more important orders prepared were those to establish plant and animal quarantines; to revoke or suspend licenses of grain inspectors; to carry into effect section 2 of the food production act; and to permit the destruction of migratory game birds in several localities where, under extraordinary conditions, they had become seriously injurious to rice crops. Forms of resolutions were prepared to enable county and other political subdivisions of States to apply to the State highway departments for Federal and State aid in the construction and maintenance of public highways; forms of inspection certificates submitted by licensed inspectors for revision; and forms of insurance policies covering goods transported by motor trucks. Some of the schedules prepared, or in the preparation of which aid was given, were those for surveys of fertilizers, farm implements, seeds, and for food and other surveys. Assistance was given in the preparation of standards for grades of American, Egyptian, and Sea Island cotton and for length of staple, for oats and rice, and specifications of commercial grades of white potatoes and butter.

At the request of the War Industries Board a representative of the office visited Vermont for the purpose of arranging for certain water-power contracts in the interest of national conservation of fuel.

In accordance with the practice heretofore established of submitting reports of violations of criminal statutes committed to the Department of Agriculture for administration, in the form of criminal informations and indictments, the cases referred to the Attorney General under the migratory bird treaty act were so reported, thus saving the time and facilitating the convenience of the United States attorneys.

Law work for the Forest Service during the year, other than under the Weeks forestry law, included handling the following cases and other business:

Claims to lands.....	575	Trespasses:	
Hearings attended.....	41	Grazing.....	359
Depositions taken.....	5	Timber.....	36
Briefs prepared and filed.....	31	Fire ¹	155
Motions for rehearings.....	31	Occupancy.....	45
Petitions for exercise of supervisory authority.....	1	Game.....	53
Oral arguments.....	1	General litigation.....	53
		Written opinions.....	233
		Contracts, leases, and similar papers.....	1214

¹ Including 104 prosecutions in State courts.

The following is a summary of the work of the office in connection with the acquisition of lands under the Weeks forestry law:

Acquisition of lands under Weeks forestry law.

Character of work.	Tracts.	Acreage.
Purchases authorized by National Forest Reservation Commission	226	127,029.00
Agreements of purchase prepared	238	173,427.00
Titles in process of examination at beginning of year	96	121,796.00
Examinations of titles completed and reported to Department of Justice:		
Purchases recommended	198	125,346.07
Condemnations recommended	80	71,215.77
Titles approved by Attorney General and in process of adjustment	37	24,756.00
Titles in process of examination at end of year	53	138,725.00
Completion of direct purchases after approval of titles by Attorney General	110	71,432.23
Completion of purchases of lands acquired by condemnation	107	147,905.22

Three meetings of the National Forest Reservation Commission were attended.

The following table shows the number of contracts and leases prepared or examined for sufficiency and proper execution for the various bureaus, divisions, and offices of the department:

Contracts and leases prepared or examined.

Bureau, division, or office.	Con- tracts.	Leases.	Bureau, division, or office.	Con- tracts.	Leases.
Bureau of Animal Industry.....	3	35	Bureau of Markets.....	2	74
Biological Survey.....	2	1	Mechanical shops.....	1	.....
Bureau of Chemistry.....	10	6	Bureau of Plant Industry.....	4	59
Chief clerk.....	2	19	Bureau of Public Roads.....	863	23
Bureau of Crop Estimates.....	5	10	Division of Publications.....	1	.....
Bureau of Entomology.....	9	51	Supply Division.....	4	.....
Office of Exhibits.....	.....	1	Weather Bureau.....	32	24
Federal Horticultural Board.....	4	5			
Forest Service.....	1,297	155	Total.....	2,243	463
Insecticide and Fungicide Board	4	.....		

During the fiscal year 43 bonds, 494 renewals, and 71 terminations of leases were prepared.

Six hundred and ninety-four written opinions, including the 233 above mentioned for the Forest Service, were rendered to the officials, bureaus, divisions, and offices of the department. In addition, numerous letters and Service and Regulatory Announcements of the Bureau of Markets, containing instructions, information, and opinions with reference to the statutes administered by that bureau, were examined, and modified or reformed where necessary. The practice was adopted during the year of answering many requests of the various bureaus of the department for opinions by brief hand-written notations on the papers containing the requests, thus saving time and expediting the answer. No record was kept of these informal opinions. A large portion of advice given administrative officials of the department was in oral conferences, of which also no record was made. Suggestions with reference to pleadings in 150 food and drugs cases were made for the assistance of United States attorneys.

Thirty applications for letters patent on inventions of employees of the department for dedication to the public were prepared and

filed. Of the applications pending at the close of the last fiscal year and of those filed during this fiscal year, 35 were allowed.

Several applications of department employees for patents were placed in interference with applications of outside parties, necessitating the taking of testimony and the presentation and argument of the cases before the Patent Office in an effort to establish priority of \$91,495,797.99, and 6,122 and a fraction miles, were reviewed, and favorable to the employees were rendered in each of these cases.

Project statements for 800 projects under the Federal aid road act, of which 761 were approved, involving a total estimated expenditure of \$91,495,797.99 and 6,122 and a fraction miles, were reviewed, and 595 project agreements under that act, with certificates of approval of plans, specifications, and estimates, involving a total estimated expenditure of \$42,178,903.91, were examined. There were also examined 185 drafts of modifications of agreement and certificates prepared by the Bureau of Public Roads. There were also examined 69 original and 12 supplemental cooperative agreements under section 8 of the act relating to roads and trails in National Forests.

Seventy-three claims for balances due estates of employees of the department who died intestate were examined, the necessary papers prepared for their payment, and advice furnished administrative officers of the department relating to the same.

Seven cases involving irregularities or misconduct of employees in their official duties were reviewed, the necessary investigations made, and appropriate papers prepared. There were nine cases of the same nature, but of less formal and serious character. Advice was also given on the special features of several other personnel cases, no record of which was preserved in this office.

Aid was given the advisory committee on finance and business methods in drafting orders and memoranda of the Secretary for the general administration of the department, and to the Office of Inspection in the consideration of a number of claims for reimbursement for property lost or destroyed while being used on official work in the National Forests.

Many Service and Regulatory Announcements, circulars, and bulletins, referred to this office by the Division of Publications for examination as to possible legal questions involved, were reviewed, and numerous letters for the Secretary's signature, prepared in the various bureaus, offices, and divisions, were referred to this office for comment prior to signature.

Many documents of various kinds, including statements of issues, briefs, and memoranda on legal matters, were prepared on behalf of the officials of this department for submission to the Attorney General, the Secretary of the Interior, the Comptroller of the Treasury, and the officials of other departments.

Hearings conducted at various places to develop the facts in regard to charges preferred against serum companies for violations of the regulations governing the preparation, shipment, and importation of viruses, serums, toxins, and analagous products intended for use in the treatment of domestic animals were reviewed and the Bureau of Animal Industry and the Secretary advised with reference to proper action thereon.

Six thousand and eight violations of statutes intrusted to the department for enforcement were reported, 4,446 to the Attorney Gen-

eral, and 1,562 to the Director General of Railroads, pursuant to an agreement between the Attorney General, the Director General, and this department for report to the Director General of violations of the animal quarantine laws and the 28-hour law occurring after the Government assumed control of the railroads. The following table shows the several statutes under which these violations were reported and the amount of fines and recoveries in cases settled with and without litigation:

Violations of statutes considered.

Law invoked.	Violations.	Fines and recoveries.
Laws for the protection of National Forests.....	597	\$74,379.30
Food and drugs act.....	1,588	18,160.00
28-hour law.....	3,123	109,850.00
Animal quarantine acts.....	179	27,000.00
Meat inspection.....	26	1,306.00
Lacey Act.....	26	1,917.00
Bird reservation trespass law.....	6	315.00
Migratory bird treaty act.....	296	2,230.00
Virus act.....	1	.....
Insecticide act.....	104	2,342.00
Plant quarantine act.....	4	.....
Standard basket law.....	1	25.00
United States grain standards act.....	4	.....
Miscellaneous.....	53	25.00
Total.....	6,008	237,549.30

Under authority of section 4 of the food and drugs act and section 4 of the insecticide act, 375 notices of judgment were prepared for publication. In addition to the criminal prosecutions above tabulated, 667 decrees of condemnation and forfeiture were entered under the food and drugs act and 5 under the insecticide act.

Aside from the cases reported to the Department of Justice, investigation was made of numerous others which could not be so reported because of the absence of proof or material facts.

Many memoranda and briefs on legal questions were furnished on cases reported to the Department of Justice for prosecution, and in some assistance was given in taking depositions and statements of witnesses and in the trials. Among the important cases in which this office assisted, either in the preparation of briefs or in the trials, or both, were *United States v. Thompson*, *United States v. Samples* and *DeLapp*, *State of Missouri v. Holland* (*United States Game Warden*), *United States v. Selkirk*, and *United States v. Greene*, all involving the validity of the treaty with Great Britain for the protection of migratory birds; *United States v. Kern River Co.*, *United States v. Harvey and Sherman*, *United States v. Hooper*, *United States v. Moore et al.*, *United States v. Davis*, *United States v. Northern Pacific Railroad Co.*, *United States v. Carbon Timber Co.*, *United States v. Safe Investment Co.*, *United States v. Sumter Valley Railway Co.*, *United States v. Utah Light & Traction Co.*, and *United States v. Nay*, all involving alleged rights to lands or the use of lands in the National Forests; *United States v. Albert Anderson* and 24 similar cases involving trespasses on the Pisgah National Forest and Game Preserve; *United States v. Parke, Davis & Co.*, and two other cases of the same nature, involving violations of the insecticide and

fungicide act; *United States v. Atlantic Coast Line Railroad Co.*, *United States v. Cleveland, Cincinnati, Chicago & St. Louis Railway Co.*, *United States v. New York, New Haven & Hartford Railroad Co.*, and *United States v. Adams Express Co.* (3 cases), all involving violations of the 28-hour law; *United States v. 432 bottles "Knoxit," United States v. Nashville Medicine Co.*, *United States v. Hall's Texas Wonder*, *United States v. Nestle's Food Co.*, *United States v. 30 dozen bottles "Knoxit," United States v. Kar-ru Chemical Co.*, all involving violations of the food and drugs act.

Tabulated statements showing in detail the facts and status of the principal prosecutions originating in the department in which the United States attorneys have commenced proceedings and of the claims and other cases affecting the National Forests are retained in this office for reference.

In addition to the opinions expressed in letters and memoranda to the various officials, bureaus, offices, and divisions of the department, frequent daily conferences were had with them with reference to legal questions involved in their work. Informal conferences between this office and the other bureaus, offices, and divisions of the department were more frequently held during the fiscal year than previously, and resulted in much saving of time to every office concerned.

The work of the office, considering its nature, was current at the end of the year.

Somewhat detailed statements of the principal activities of the office, without unnecessary reiteration of what has been fairly covered by the foregoing summary, follow.

THE NATIONAL FORESTS.

LAND CLAIMS.

At the commencement of the fiscal year there were pending 401 cases. During the year there were added 174, and 231 were closed, leaving 344 pending. A total of 575 cases were handled, involving land claimed under the homestead, timber and stone, mineral, lieu and railroad selections, and other general and special land laws.

Two hundred and sixty-one decisions were rendered, including those of registers and receivers and the Commissioner of the General Land Office, subject, respectively, to review by the Commissioner of the General Land Office and the Secretary of the Interior. The registers and receivers decided 13 for and 13 against the Government, the commissioner decided 106 for and 57 against the Government, and the Secretary decided 31 for and 37 against the Government. Fourteen were suspended for further action and 18 for taking additional testimony. Of the 231 cases closed during the year, 80 were by decisions for the claimant and 96 by decisions in favor of the Government. In 5 cases the proof was rejected or withdrawn. Thirteen were canceled by relinquishment, and in 37 the protests were withdrawn. In 29, such withdrawals were made after the commissioner had reduced the area required to be cultivated under the homestead laws. As a result of the 96 decisions in favor of the Government, approximately 9,129 acres of land, supporting a stand of approximately 53,813,140 feet of timber, valued at approximately \$161,439, were retained in the National Forests. The remain-

ing 344 cases received attention varying in degree with their progress in the Forest Service and in the Department of the Interior. Hearings were attended in 41 cases. Depositions were taken in 5 cases. Briefs were filed in 31 cases. One case was orally argued before the Secretary of the Interior. Thirty-one motions for rehearing were filed, 8 of which were accompanied by briefs; 2 appeals to the Secretary of the Interior, supported by briefs, were prosecuted from adverse decisions by the commissioner; and 1 petition for the exercise of supervisory authority, accompanied by brief, was made to the Secretary.

The assistants to the Solicitor in the field examined and passed upon the evidence in many cases in addition to the 174 new cases in which protests were prepared to be filed in the local land offices by the district foresters, and either returned the papers for additional evidence or recommended that no objection be made to the issuance of patent.

TRESPASS.

Damages and fines recovered during the year for trespasses upon the national forests were:

Penalties for trespass on national forests.

Class of trespass.	Damages.	Fines and recoveries.	Class of trespass.	Damages.	Fines and recoveries.
Grazing.....	\$43,256.61	\$1,596.95	Occupancy.....	\$38.44	\$759.44
Timber.....	6,569.67	120.00	Miscellaneous.....	8,784.47	.....
Fire.....	12,365.22	888.50	Total.....	71,014.41	3,479.90
Game.....	.....	115.01			

In addition, prosecutions in State courts were instituted in 102 cases, resulting in fines of \$3,380 and jail sentences totaling 1,400 days.

In the 53 cases instituted on account of hunting or killing of game animals on the Pisgah National Game Preserve and the national forests in violation of the department's rules and regulations, 34 defendants were found guilty and fined, and sentences aggregating 55 days in jail were imposed, 3 were dismissed because defendants were out of the State, 2 defendants were found not guilty, 1 case was dismissed for lack of evidence, 2 were continued, 2 were dismissed, and 9 are awaiting trial.

GENERAL FORESTRY LITIGATION.

Thirty-six cases not properly included within the above, both criminal and civil, were handled by district assistants, or aid given United States attorneys in conducting them during the year, among which were the following: *United States v. Northern Pacific Railway Co.*, a suit for the cancellation of patent issued to the company, argued in the Circuit Court of Appeals in May, 1919; *United States v. Milwaukee Lumber Co.* and the *Fidelity & Deposit Co. of Maryland*, involving timber cut from a canceled homestead entry, settled by the defendant; two cases before the Interstate Commerce Commission and one before the public service commission of Oregon, in-

volving rates on timber; a charge of obtaining a railroad ticket from the Forest Service under pretense of going to assist in fighting forest fires, defendant pleaded guilty and was sentenced to 10 days in jail; suit to cancel a right of way; suit to cancel patent to a mineral claim in which demurrer to the bill was sustained; a forest ranger was bound over for trial by the State court on a technical charge of murder, resulting from shooting while assisting a State officer in making an arrest for felony, the grand jury failed to indict; on the charge of personating a forest officer, the defendant was acquitted; in a prosecution for criminal libel defendant was found guilty and sentence is now pending; on a charge of larceny of Government property defendant was found guilty and fined \$25; on a charge of bribery the case was dropped for lack of evidence; breaking into a ranger station, defendant found not guilty; a suit to cancel a mineral patent, decision by the United States district court in favor of the defendant was affirmed by the Circuit Court of Appeals; one suit for the condemnation of lands; five cases involving water rights; one action for breach of timber sale contract; injunction suit to terminate an illegal inclosure; for killing a forest ranger while attempting to make an arrest of one Archuletto, who was evading military service, Archuletto was given a life sentence, and a companion, Martinez, was sentenced to 15 years.

FORESTRY COURT DECISIONS OF INTEREST.

In *Caldwell & Dunwoody v. United States*, the Supreme Court, on May 19, 1919, held that the plaintiffs were not entitled to recover from the United States the proceeds of the sale of the "tie slash" or tops of trees the trunks of which had been used in making ties for the Denver, Northwestern & Pacific Railway Co. Plaintiffs had contracted to furnish ties to the railroad, which had the right under the act of March 3, 1875 (18 Stat. 482), to cut timber for railroad purposes from the public lands adjacent to its road, and had been advised by the chief of the field division of the General Land Office in whose district the land was located that they might sell the tie slash. When the lands were included on March 7, 1907, within the Medicine Bow National Forest, the officers of the forest service took possession of and sold tie slash, permitting the plaintiffs to take only the poles they had already cut and the slash within the "fire guard" 200 feet wide for a distance of 2 miles along the road. Plaintiffs sought to recover the money received from the sale of this tie slash. The court held that under the act of 1875 the railroad company was entitled to timber for construction purposes only and not as a means of business or profit, and that plaintiffs were not entitled to the benefits of the act of March 3, 1891 (36 Stat. 1095, 1099), permitting the cutting of timber from the public lands for agricultural, mining, manufacturing, and domestic purposes, because of the express provision that nothing in that act shall operate to enlarge the rights of any railroad company.

In *Union Land & Stock Co. v. United States*, 257 Fed., 635, the Circuit Court of Appeals for the Ninth Circuit, on May 9, 1919, held that suit may be maintained without a special act of Congress for the forfeiture of a grant of any irrigation right of way under the act of 1891.

The case of *United States v. Myron Nay* was decided in the United States District Court at Salt Lake City on January 28, 1919, and involved the use of mineral claims merely for residence purposes. A permanent injunction was obtained and the defendant was removed from the premises. The case is of importance in that it is a judicial determination of the validity of a mineral claim without preliminary proceedings in the Land Office for adjudication of the character of the lands.

Several cases arose on the Teton National Forest involving the killing of elk in violation of the regulations of the Department of Agriculture. A motion to dismiss, based on the ground that the Secretary of Agriculture was without authority to promulgate such regulations, was sustained. Appeals on behalf of the Government are pending.

The case of *United States v. Kern River Co.*, decided February 10, 1919, involved the cancellation of an irrigation easement granted under the act of March 3, 1891, for failure to use the grant for any purpose contemplated by the act, it having been used for power purposes alone. The District Court for the Southern District of California dismissed the bill, holding that fraud or mistake in making the grant had not been established and that the suit could not be maintained and the grant canceled without special act of Congress authorizing the suit and forfeiture of the grant. The Government's appeal to the Circuit Court of Appeals is pending.

The case of *United States v. Milwaukee Lumber Co. and Fidelity & Deposit Co. of Maryland*, decided in favor of the Government on June 21, 1919, was an action to recover \$3,954.43, and involves a contract bond given to the United States to cover payment for the timber cut from the Elizabeth Davis homestead claim. The bond contained a stipulation to the effect that in the event the entry was relinquished or canceled by a proper officer of the Interior Department, the lumber company would pay to the United States the value of the timber. The claim was canceled and demand made upon the lumber company for the money, which was refused, but finally the money was deposited in the Federal court of Idaho. The homesteader intervened, and while the matter was pending, Congress passed a bill authorizing the Secretary of the Interior to issue a patent. The bill provided that the issuance of patent should not relieve the lumber company from its obligation to pay for the timber.

IMPORTANT FORESTRY OPINION OF THE ATTORNEY GENERAL.

In the case of *Allen L. Newton*, involving a homestead entry within a national forest, the Attorney General, by letter of July 17, 1918, to the Secretary of the Interior, expressed the opinion that the proviso to section 7, act of March 3, 1891 (26 Stat., 1095), which directs the issuance of patent where no protest or contest is pending at the expiration of two years after the issuance of receiver's final receipt, as such proviso was interpreted by the Supreme Court in *Lane v. Hoglund*, 244 U. S., 174, does not require the Secretary of the Interior to issue patent where fraud is involved, and that if the proof of fraud was so clear, unequivocal, and convincing as to warrant a suit to cancel the patent, a suit should be instituted to cancel the final receipt and entry, and that pending the determination of such suit the patent should be withheld.

WEEKS FORESTRY LAW.

[36 Stat., 961.]

During the period of the war Congress made no additional appropriation for the extension of the work under this act, and as a consequence, as well as because of the many war activities demanding the attention of the individual members of the force engaged upon the work, the results during the fiscal year have not been as extensive and the acreage acquired not as great as in the previous year. It is believed, however, that the work accomplished, when considered from the standpoint of the force engaged thereon, relatively has been as large as in previous years.

During the year the National Forest Reservation Commission authorized the acquisition of 226 tracts of land aggregating 127,029 acres.

In order to meet the demands of the work incident to additional authorized acquisitions, new offices have been established at Mena, Ark., and at Murphy, N. C., the former to facilitate the examination of titles to lands to be acquired in the Arkansas and Ozark areas and the latter for the purpose of making further examination of title to the so-called "Olmstead" lands turned over to the department for forest purposes by the Treasury Department under the act of Congress of 1912, and also for the purpose of examining titles of interior and contiguous tracts to be acquired for filling out the area.

In the past considerable delay in the acquisition of lands and the payment therefor was occasioned by the congested condition of the work in the offices of the United States attorneys, due to the unprecedented amount of work arising from war conditions. It was, therefore, necessary, in order to meet the complaints on the part of the vendors at the delay in receiving payment of purchase money and awards for lands taken over by the department, to effect arrangements whereby the United States attorneys' offices could be relieved of a portion of the detail incident to the condemnation of lands which could not, because of defects in titles, be acquired by direct purchase. This condition is now being met by this office preparing all the petitions and other papers incidental to the condemnation proceedings.

While this procedure has considerably increased the work of this office, the results attained have undoubtedly warranted the undertaking and have materially expedited payments to vendors as well as relieved the pressure in the offices of the United States attorneys.

The following is a summary, in terms of acres, of operations under the Weeks forestry law from the beginning to June 30, 1919.

Operations under the Weeks forestry law from the beginning to June 30, 1919.

State.	Area.	Purchases authorized (estimated).	Purchases completed (actual survey).	Reports in Department of Justice.	
				For opinion (actual survey).	For condemnation (actual survey).
		<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Alabama.....	Alabama.....	52,526	22,763.17	5,523	5,671
Arkansas.....	Arkansas.....	8,359	1,397.52	3,635	
	Ozark.....	9,130		1,619	
Georgia.....	Georgia.....	64,127	60,23.72		
	Savannah (S).....	84,429	47,418.53		
Maine.....	White Mountain.....	29,547	27,859.78		
New Hampshire.....	do.....	384,815	332,777.88		31,797
North Carolina.....	Boone.....	45,839	25,917.35		21,220
	Mount Mitchell.....	88,157	67,112.69	24	6,159
	Nantahala.....	75,704	35,183.82		138
	Pisgah.....	94,588	79,471.20		9,495
	Savannah (N).....	43,346	33,528.50		128
South Carolina.....	Savannah (S).....	24,084	18,454.26		
Tennessee.....	Cherokee.....	141,188	91,889.38	18,365	6,848
	Smoky Mountain.....				
	White Top.....	44,380	47,112.63		
	Unaka.....	56,129	39,944.90		5,070
Virginia.....	Massanutten.....	63,537	50,531.75	257	5,401
	Natural Bridge.....	110,052	77,699.60	5,778	1,745
	Potomac.....	41,410	30,024.95		3,398
	White Top.....	23,311	22,096.63		307
	Shenandoah.....	169,244	132,265.94		412
West Virginia.....	Monongahela.....	55,549	46,268.30		
	Potomac.....	41,436	31,581.12		7,058
	Shenandoah.....	18,000	13,318.45		528
		1,768,927	1,334,842.07	35,201	105,375

^a Part of this acquisition authorized as being in Unaka area.

THE PLANT QUARANTINE ACT.

[37 Stat., 315.]

Four cases were reported to the Attorney General, all under section 8 (domestic quarantines) of the act as amended by the appropriation act of March 4, 1917 (39 Stat., 1134, 1165). At the close of the fiscal year 1918 there were 14 cases pending. Three cases which were closed prior to the beginning of the fiscal year 1918 were not reported to this office until too late for their inclusion in the annual report. Of the 4 new cases, 1 was withdrawn upon the request of the Federal Horticultural Board; 1 other case was not pressed. There are now 15 cases pending. A number of proposed orders of the Secretary of Agriculture to establish, and of regulations to enforce, quarantines under the law were examined as to their legal form and sufficiency.

FEDERAL AID ROAD ACT.

[39 Stat., 355.]

Projects statements for 800 projects were reviewed during the year to determine whether the projects were eligible for Federal aid under the provisions of the act. Of these, 761 were approved, involving a total estimated expenditure of \$91,495,797.99, and Federal aid in the

amount of \$38,264,394.85, and involving 6,122.824 miles of road. In many cases where some part or all of the project was not being used as a rural post road and there was not sufficient evidence to establish a reasonable prospect that it would be so used within a reasonable time, it was necessary to point out in detail the character of additional evidence which should be furnished to establish the eligibility of the project. In some instances elimination of a portion or portions of the project was suggested where it was impossible to furnish sufficient evidence of a reasonable prospect of use for mail transportation.

Project agreements and certificates of approval of plans, specifications, and estimates, prepared by the Bureau of Public Roads, for 595 projects were examined as to their legal form and sufficiency before being transmitted to the State highway departments for execution, and of these agreements and certificates 453 were subsequently examined as to the sufficiency of their execution by the State highway departments and were thereupon submitted to the Secretary to be executed by him. These agreements involved a total estimated expenditure of \$42,178,903.91 and Federal aid aggregating \$18,273,159.17.

Drafts of modifications of agreements and certificates, prepared by the Bureau of Public Roads, were similarly reviewed in 185 cases, and cancelations of agreements in 2 cases. Of the drafts of modifications of agreements so reviewed, 163 were subsequently examined as to whether they were properly executed by the State highway departments and were submitted to and executed by the Secretary.

Statutes of five States, amending former highway statutes, were reviewed to determine whether they met the requirements of the Federal aid road act.

Proposed standard plans, specifications, and orders to bidders, and contract and bond forms used by a number of the States in carrying out the cooperation contemplated and authorized by the act, which were submitted for consideration by the several State highway departments, were reviewed as to their legal form and sufficiency. Suggestions as to changes in form and substance were made in several instances.

Forms of resolutions to be used by the counties and other civil subdivisions in applying to their respective State highway departments for State and Federal aid in accordance with the State laws were drafted for the convenience of the State highway departments concerned.

Opinions were rendered on a number of important questions arising under the act. In addition to the above list, 69 original agreements and 12 supplemental agreements under section 8 of the act were reviewed both as to form and substance.

As indicated in the summary of this report, the work of the Bureau of Public Roads and of the Forest Service was materially enlarged by additional appropriations and by the enlargement of the class of roads comprehended in the phrase "rural post road" as used in the Federal aid road act.

THE FOOD AND DRUGS ACT.

[34 Stat., 768.]

Fifteen hundred and eighty-eight cases were transmitted to the Department of Justice, in 413 of which criminal proceedings and in 1,175 of which seizures were recommended. The 413 criminal cases embraced 860 alleged violations of the food and drugs act.

At the close of the fiscal year 1918, 398 cases were pending, of which 188 were criminal prosecutions and 210 were seizures.

Two hundred and fifty-four cases pending at the close of the fiscal year 1918 and 765 reported during the fiscal year 1919, in all 1,019, were terminated in 1919. Of those terminated, 271 were criminal and 748 were civil.

In 244 of the 271 criminal cases fines were imposed. Most of these cases were disposed of by pleas of guilty or nolo contendere. There were trials in only 2 resulting in convictions and 1 of these is now pending on appeal; in 6 collateral deposited by defendants was forfeited by reason of their nonappearance in court. In 1 the judgment of conviction in the lower court was reversed by the Circuit Court of Appeals, in 3 there were acquittals, 22 were nol-prossed or the information dismissed, and 1 was withdrawn from prosecution.

In the criminal cases in which convictions were obtained the fines were as follows:

Fines assessed under food and drugs act in cases reported by this department to the Department of Justice.

Number of cases.	Amount of fine.	Total.	Number of cases.	Amount of fine.	Total.
6	\$5.00	\$30	1	\$110	\$110
1	7.00	7	7	150	1,050
22	10.00	220	4	160	640
3	15.00	45	1	175	175
23	20.00	460	11	200	2,200
2	22.50	45	1	210	210
43	25.00	1,075	1	225	225
10	30.00	300	1	250	250
4	40.00	160	1	300	300
53	50.00	2,650	1	350	350
5	60.00	300	2	400	800
1	65.00	65	1	450	450
1	70.00	70	3	500	1,500
7	75.00	525	1	603	603
1	90.00	90	1	750	750
24	100.00	2,400			
1	105.00	105	244	.....	13,160

In addition to the fines imposed, costs were generally assessed.

Of the 748 civil cases terminated during the year, decrees of condemnation and forfeiture or informal orders for the disposition of the property were entered in 667, of which 5 were decided favorably to the Government after contest, in 30 the libels were dismissed, in 44 the packages were broken or disposed of before seizure could be made, and in 7 verdicts were returned for the claimant after trial to the court and a jury. In the 667 cases, in which decrees of condemnation and forfeiture were entered, the goods were destroyed in 340, released on bond or otherwise in 266, and sold in 61. In many of the cases in which the product was ordered released or sold,

the decree of the court provided that the product should be sorted and that portion found unfit for food should be destroyed.

At the close of the year 967 cases were pending, of which 330 were criminal prosecutions and 637 were seizures.

In addition to the cases reported by this department to the Department of Justice, the food and drugs officials of the various States and the District of Columbia, collaborating with the department in the enforcement of the act, are shown by the records of this office to have reported 55 cases to the United States attorneys which were terminated during the year. Of these, 42 were criminal cases and 13 were seizures. In all of the criminal cases there were pleas of guilty or nolo contendere, or the collateral deposited by defendants was forfeited on account of their nonappearance. In all of the seizure cases, except one in which the goods were not located, decrees were entered and the products released on bond in 4 cases, destroyed in 6, and ordered sold in 2 cases. The fines or amounts forfeited as collateral in the criminal cases were as follows:

Fines in food and drug cases begun by United States attorneys.¹

Number of cases.	Amount of fines.	Total.	Number of cases.	Amount of fines.	Total.
3	\$20	\$60	1	\$100	\$100
27	25	675	1	200	200
2	30	60			
7	50	350			1,445

¹ One personal bond taken.

Three hundred notices of judgment were published during the year.

FOOD AND DRUGS CASES OF INTEREST.

In the case of the United States *v.* 141 bottles, etc., of drug products (F. & D., 9377), involving the seizure of a drug known as "A Texas Wonder" in the Southern District of Texas, which was labeled in such manner as to claim for it certain therapeutic and medicinal properties, the intervening claimant pleaded *res adjudicata* by reason of a verdict and judgment of not guilty in a criminal proceeding instituted against the shipper of the article in the Eastern District of Missouri. In the present case the court denied the plea of former judgment for the reason that—

an essential element of the offense under this act is the statement of mind of defendant, a factor necessarily subject to constant change. To contend that a prosecution or proceeding which turned not, as most offenses do, on the commission of the overt act, but on the state of mind of the defendant, would constitute a bar to a proceeding based upon the defendant's state of mind at a later date, is essentially unsound.

In commenting on the fraudulent character of the labeling the court said:

The defendant admits that he is not himself a physician, though many of his circulars and advertisements declare him to be "Dr. E. W. Hall," nor does he claim for himself any special medical skill or knowledge. He relies most largely upon the fact of the sales to thousands of purchasers, and the numerous and glowing testimonials about cures, which he no doubt received, as an evidence that he could not be guilty of fraud in the matter. But the slightest reflection upon the well-known fact that persons given to self-medication are credulous and partisan, and prone to deny nature credit for their recovery, and

that on this well-known trait of human nature these compounders of specifics and nostrums build their business, deprives this claim of any weighty significance, because it will not do for a person who has been able to prey upon the credulity of a community to escape the consequences of his acts by the very success of his scheme. * * *

It would be sufficient, in my judgment, to sustain the libel, for me to hold that the defendant did not know that his statements were false, but merely made them recklessly and without due regard for that fact. But I think the evidence establishes more, and leaves no doubt that the defendant is seeking, by a broad and comprehensive claim for his medicine, to increase its sales, with an absolute knowledge on his part of the falsity of his advertisements, certainly as to a part of the matters claimed for it.

* * * The danger and injury to the public from this character of advertisements is, however, considerable in that it induces persons to rely in serious cases upon a preparation without healing virtue when except for this reliance they would no doubt secure proper advice and treatment for the ills which affect them.

In the case of the *United States v. 275 cases mineral water* (F. & D., No. 8752), instituted in the Western District of Louisiana and involving the shipment in interstate commerce of certain mineral water for which various medicinal and therapeutic effects were claimed on the labels, the court instructed the jury as follows:

If you find that the water was not of value for the purposes recommended, but that defendant acted in good faith, then there should be a verdict in his favor, but if you find that the water was not of value for the purposes recommended, to the knowledge of the defendant, and that his purpose was to deceive and impose upon the public, then you should return a verdict for the Government.

* * * * *

The pure food and drugs act is one of the best laws of its character placed on the statute books in many years. It simply means that a man shall correctly brand or label that which he ships in interstate commerce, that the purchaser must be informed of the character of the article bought, and must not be deceived as to its curative properties; in other words, that the drug must not be sold under false representations.

In the case of the *United States v. Italian Importing Co.* (F. & D. 9431), instituted in the Southern District of New York and involving a violation of the net weight amendment and the rules and regulations thereunder in short-filling cans with olive oil, the court instructed the jury as follows:

Now, those rules and regulations permit a certain variation, but of course it does not permit willful conduct or intentional or willful underweighing or undermeasuring of the contents; that is, placing and undermeasuring in the tin can or the package and then misbranding it and saying it is more than in truth and in fact it is, but inadvertence may be of importance in this regard only: If it is done in good faith, without intent to do wrong, without willful design to do wrong in the usual course of its business, in ignorance or in inadvertence filling these cans, and at underweight or undermeasurement, then you can see they would not be guilty, because no man under our law can commit a crime through a mistake. The commission of a crime depends upon a criminal intent. Of course, it is true that the law is that a man is presumed to intend the natural and flowing consequences of his act.

In the case of the *United States v. Kar-Ru Chemical Co.* (F. & D. 8315), instituted in the Western District of Washington and involving a violation of the Sherley amendment to the food and drugs act, the court instructed the jury that—

it would not be necessary to prove that the entire label, that all of the representations on the label regarding the curative and therapeutic effect of the contents were false and fraudulent.

Upon the question of a reasonable doubt, the court said that it—
is a doubt that is based upon reason, a doubt for which you can give a reason. It does not mean every possible doubt, because it is almost impossible to establish a particular truth, and especially the truth of the assertions that rest in opinions regarding men's ailments and what cures them to an exact certainty and beyond all possibility of a mistake, but it does mean more than mere probability or mere preponderance of evidence.

In the case of the United States *v.* 1038 Cases of Tobasco Catsup (F. & D. Nos. 9414 to 16), instituted in the Eastern District of Missouri, the court in discussing the sixth paragraph of section 7 of the food and drugs act, in the case of food, said to the jury:

Now, let me read it again: "If it consists in whole or in part of a filthy, decomposed or putrid animal or vegetable substance." Now, the Congress, in section 6, based a reasonable application of this section to the practical business affairs of life. In such a case the Congress intended that it should apply to the absolute term. * * * But the word, * * * here, with which we are principally interested in this trial is in its everyday use, and not in the scientific sense. In the scientific sense wine, or beer, would be absolutely prohibited in this case; as you gentlemen all know the grain with which beer is made and the grapes with which wine is made are fermented. Again there are lots of food products that the Congress—made out of partially decomposed vegetable matter, in some instances at least—that the Congress didn't intend to prohibit. * * * So, if we had to make tomato catsup out of tomatoes which were not in part decomposed we could never make any tomato catsup, because it would be a matter of impossibility for anyone to engage in the manufacture of catsup, and there would be some decomposed tomato matter going into the product. The care with which you would have to conduct a business of that kind would absolutely prohibit the business. So, what the Congress meant—it meant this, that in the manufacture of tomato catsup, which is the subject of this, that the rule of reason should enter; that is to say, a factory that exercised a reasonable, prudent caution in collecting the tomatoes, and assorting those that went into the cylinder so as to cut out any, unreasonably so, of decomposed tomatoes—the manner of a reasonably prudent, careful, and intelligent man, engaging in his affairs, would do; that he be protected under the law, unless he became careless in his business and allowed rotten tomatoes to go in there in a manner that a reasonable, prudent man, making a product for consumption of his own, would not do.

In the case of the United States *v.* D. Auerbach & Sons (F. & D., No. 7378) instituted in the Southern District of New York, which resulted in a mistrial and the subsequent entry of a nolle prosequi to the information, the defendants were charged with shipping in interstate commerce candy in 30-pound pails labeled in part "Chocolate Flavor Pecan B Bons." The court charged the jury that it was immaterial whether the consignee to whom the candy was shipped knew what he was getting or was deceived, and that—

The pure food law is intended to protect the ultimate consumer, the general public * * *. When you come to consider what the ultimate consumer, the general public, would think, you have to take into consideration there the price at which it was sold, the character of the people that would probably buy it, and what they would expect to get. * * * You will take into consideration all those facts and apply your knowledge as reasonable business men to them. * * *

You must now determine whether or not this particular product when it was shipped was so colored as to conceal its inferiority and give the impression that it was something which it was not—that is the purpose of the pure-food law, that things shall be sold for what they are and not for what they are not, and that they must not be adulterated or the inferiority concealed in any way. If they are shipped in interstate commerce, and they are adulterated so that they appear to be something that they are not, and the public is thereby deceived, then of course that is a violation of the law.

After consideration the jury returned to the court room for further instructions, and the court then charged them, in part, as follows:

There is nothing deleterious in this candy. The law permits candy to be artificially colored; the law does not permit something to be artificially colored, however, to imitate something else. That is the distinction. * * *

Would a person going in to buy this candy at retail, at 10 cents a pound, think that he or she was getting chocolate candy because it looked like chocolate candy; would the price have anything to do with that, considering the people that bought it, the class of people that would go to a 5, 10, and 15 cent store, children buying it, all those kind of things—you have to apply your knowledge of affairs as men of the world; you will have to put yourselves in the place of the person who might be tempted to buy this candy; that is the way you have to look at it, in a plain common sense way, and then you have to determine whether or not this candy was artificially colored to conceal its inferiority. If it was, your verdict must be guilty.

In the case of the United States *v.* Cleveland Macaroni Co. (F. & D., No. 7656) instituted in the Northern District of Ohio, upon the demurrer of the defendant company to the information filed in the case, the court ruled as follows:

Upon examination of the information and briefs of counsel, I am of opinion that proper pleading does not require that the exceptions contained in section 8 of the food and drugs act be negatived in the information * * *.

MEAT INSPECTION.

[34 Stat., 674.]

Twenty-six cases were reported to the Attorney General. At the close of the fiscal year 1918, 48 cases were pending.

Of the cases reported during the fiscal year 1919, 17, and of those pending at the close of the fiscal year 1918, 26, in all 43, were terminated during the fiscal year 1919. Of these 27 resulted in convictions, 10 were dismissed, 2 were nol-prossed, and in 4 grand juries refused to return indictments. Fines aggregating \$1,306 were imposed in 27 cases, as follows:

Fines imposed in meat-inspection cases.

Cases.	Fine.	Total.	Cases.	Fine.	Total.
1	\$1	\$1	2	\$75	\$150
6	5	30	2	100	200
1	10	10	1	500	500
2	20	40	27	-----	1,306
9	25	225			
3	50	150			

At the close of the fiscal year 1919, 37 cases were pending.

MEAT-INSPECTION CASES OF INTEREST.

The case of Pittsburgh Melting Co. *v.* Totten (an inspector of the department), involved the question whether a certain oleo oil having the characteristics of an edible product, which the company shipped in interstate commerce as an inedible product, was entitled to such transportation without being denatured and accompanied by an inedible certificate, as required by the regulations of the Secretary of Agriculture. The Supreme Court on November 4, 1918,

upheld the United States Circuit Court of Appeals in its opinion that the product was in fact edible and therefore not entitled to transportation in interstate commerce, except in compliance with the regulation of the statute requiring inspection before shipment.

In the case of Brougham, et al. *v.* Blanton Manufacturing Co., decided by the Supreme Court on April 21, 1919, the appellee failed in an effort to enjoin the appellants, officers of the Department of Agriculture, from interfering with it in the use of the word "Creamo" as a trade-mark in the manufacture and sale of oleomargarine, it being held that the term was false and deceptive, and that if it were claimed to be an established trade name it had not received the approval of the Secretary of Agriculture.

In David F. Houston et al. *v.* St. Louis Independent Packing Co., decided on April 14, 1919, the Supreme Court upheld a regulation promulgated by the Secretary of Agriculture under the meat-inspection act which provided that sausage shall not contain cereal in excess of 2 per cent; that when added such fact shall be stated on the label or product; and that water or ice shall not be added except to facilitate grinding, chopping, and mixing, and then not in excess of 3 per cent.

THE TWENTY-EGHT-HOUR LAW.

[34 Stat., 607.]

One thousand seven hundred and eleven cases were reported to the Attorney General and 1,412 to the Director General of Railroads; in all 3,123 reported during the fiscal year. This is an increase over the preceding year of 1,955 cases reported for action.

At the close of the fiscal year 1918, 2,831 cases were pending.

Of the cases reported during the fiscal year 1919, 434, and of those pending at the close of the fiscal year 1918, 547, in all, 981, were terminated during 1919.

Penalties aggregating \$109,850 were recovered in 849 cases. One hundred and twelve cases were dismissed and 20 were determined adversely to the Government.

Two thousand and thirty-seven cases were pending at the close of the fiscal year.

Penalties assessed under the 28-hour law.

Number of cases.	Penalty.	Total amount.	Number of cases.	Penalty.	Total amount.
722	\$100	\$72,200	13	.....	\$400
24	125	3,000	12	.....	1,000
23	150	3,450	10	.....	500
1	175	175	10	.....	900
19	200	3,800	7	.....	800
1	225	225	5	.....	100
8	250	2,000	5	.....	200
7	300	2,100	2	.....	100
1	400	400	3	.....	100
1	500	500	3	.....	400
12	.....	100	6	.....	675
6	.....	1,600	6	.....	500
6	.....	1,600	5	.....	600
6	.....	3,200	3	.....	500
6	.....	2,200	3	.....	400
6	.....	1,300	8	.....	700
6	.....	1,400	3	.....	325
6	.....	1,300			
2	.....	100	958	.....	109,850
11	.....	1,000			

¹ Lump penalties.

ACTS REGULATING THE INTERSTATE MOVEMENT OF LIVE STOCK FROM QUARANTINED DISTRICTS, PROHIBITING THE INTERSTATE MOVEMENT OF DISEASED LIVE STOCK, AND PROHIBITING THE IMPORTATION OF DISEASED LIVE STOCK.

[23 Stat., 31; 26 Stat., 414; 32 Stat., 791; 33 Stat., 1264.]

Fifteen cases involving violations of the act of May 29, 1884 (23 Stat., 31), were reported to the Attorney General for prosecution. Seven cases reported during the year and one pending at the close of the fiscal year 1918 were terminated, with fines of \$100 imposed in each case. In one case reported during the year and in one case pending at the close of the fiscal year 1918, grand juries failed to indict.

No cases were reported to the Attorney General under the act of August 30, 1890 (26 Stat., 414).

Two cases were reported to the Attorney General for prosecution under the act of February 2, 1903 (32 Stat., 791), which were pending at the close of the year. One hundred and two cases were pending at the close of the fiscal year 1918, 74 of which were terminated. Fifty-three cases resulted in convictions, in each of which a fine of \$100 was imposed, and 21 cases were dismissed. Twenty-one violations of this act were reported to the Attorney General for transmission to the Director General of Railroads. At the close of the year seven of these violations had been given consideration by the Director General of Railroads and disposed of by him.

Twelve violations of the act of March 3, 1905 (33 Stat., 1264), were reported to the Attorney General. At the close of the fiscal year 1918, 335 cases were pending. Two hundred and fifty-seven cases pending at the end of the fiscal year 1918, and three cases reported during the year 1919, in all 260, were terminated. Two hundred and seven cases were terminated by convictions, in each of which a fine of \$100 was imposed; in one case a fine of \$200 was imposed; and 53 cases were dismissed. One hundred and twenty-nine violations of this act were reported to the Attorney General for transmission to the Director General of Railroads. At the close of the year 59 of these violations had been given consideration by the Director General of Railroads and disposed of by him.

The fines imposed under the animal quarantine laws were:

Fines imposed under animal quarantine laws.

Number of cases.	Amount of fines.	Total.
268 1	\$100 200	\$26,800 200
269	.....	27,000

In each of the cases reported to the Attorney General for prosecution under the acts of February 2, 1903, and March 3, 1905, a suggested form of indictment or criminal information was prepared and submitted therewith for use by the United States attorney in the prosecution.

THE VIRUS ACT.

[37 Stat., 832.]

One apparent violation of the act of March 4, 1913 (37 Stat., 832), governing the preparation, shipment, and importation of viruses, serums, toxins, and analogous products intended for use in the treatment of domestic animals, was reported to the Attorney General. This case was pending at the close of the fiscal year.

In several cases involving the suspension or revocation of licenses issued by the secretary to manufacturers of these products, the testimony given at the hearings was reviewed by this office and the secretary advised as to its legal effect.

THE INSECTICIDE ACT.

[36 Stat., 331.]

One hundred and four cases were reported to the Attorney General, in 90 of which criminal proceedings and in 14 seizures were recommended. At the close of the fiscal year 1918, 80 cases were pending, all of which were criminal prosecutions. Forty-five cases pending at the close of the year 1918 and 44 reported during the year 1919, in all, 89, were terminated during the year. Of the cases terminated, 83 were criminal and 6 civil. In the 83 criminal cases, fines were imposed in 69; 12 were dropped or dismissed; in 1 collateral was forfeited; in 1 case a verdict in favor of the Government was reversed in the Circuit Court of Appeals. After combination of the cases for purpose of prosecution, in 64 pleas of guilty, in 5 pleas of nolo contendere were entered, and in 1 collateral was forfeited.

In the criminal cases in which convictions were obtained, the fines were as follows:

Fines assessed under the insecticide act.

Number of cases.	Amount of fine.	Total.	Number of cases.	Amount of fine.	Total.
1	\$1	\$1	3	\$30	\$90
1	4	4	1	45	45
5	5	25	7	50	350
1	7	7	3	100	300
10	10	100	1	150	150
3	15	45	1	400	400
5	20	100			
29	25	725	70	-----	2,342

Costs were assessed in a number of cases in which convictions were obtained. Decrees of condemnation and forfeiture were entered in 5 civil cases and 1 case was dismissed. At the close of the year 95 cases were pending, of which 87 were criminal prosecutions and 8 were seizures. Seventy-five notices of judgment were prepared.

THE MIGRATORY-BIRD TREATY ACT.

[40 Stat., 755.]

The treaty with Great Britain for the protection of migratory birds was proclaimed by the President December 8, 1916. On July 3, 1918, the President approved the act of Congress to carry the treaty into effect, and on July 31, 1918, approved and proclaimed the

regulations adopted by the Secretary of Agriculture to give effect to the act. The administration of the act is committed to the Bureau of Biological Survey of the Department of Agriculture.

The bureau referred to this office during the year 351 cases for consideration, of which 296 were reported to the Department of Justice for action. The first case under the act was a libel filed in the district of Maryland for the forfeiture and confiscation of two barrels of rice birds shipped from Georgia to Baltimore. Decree was entered forfeiting the birds and ordering their distribution among charitable institutions in Baltimore.

The question of the validity of the treaty and the act to carry it into effect was raised early in the year in the Eastern District of Arkansas, in the case of *United States v. E. D. Thompson*, 258 Fed. 257, and at the request of the Department of Justice this office prepared a memorandum on the constitutional questions raised for consideration of the court. The court sustained the treaty and the act. While this case was pending the State of Missouri, by its attorney general, filed a bill in the United States District Court for the Western District of Missouri, seeking to enjoin the United States game warden and his deputies from enforcing the act of Congress in that State. The office furnished the United States Attorney with a memorandum on the constitutional questions raised and with other pertinent data. On July 2, 1919, the court dismissed the bill for injunction and sustained the treaty and the act of Congress. (*Missouri v. Holland*, 258 Fed. 479). The treaty and the act were also sustained in *United States v. Selkirk* in the Southern District of Texas (258 Fed. 775). The validity of the treaty and the act was also raised in the case of *United States v. Green*, in the Northern District of Florida, and was argued on behalf of the United States by one of the assistants in this office. The court sustained the treaty and the act. There have been no adverse decisions.

Of the cases reported to the Department of Justice for prosecution, 110 have resulted in convictions and the imposition of fines amounting to \$2,230. The fines imposed were as follows:

Fines imposed under the migratory-bird treaty act.

Number of cases.	Amount of fines.	Total.	Number of cases.	Amount of fines.	Total.
2	\$1	\$2	20	\$25	\$500
1	3	3	9	50	450
47	5	235	8	100	800
22	10	220			
1	20	20	110	.....	2,230

In addition, two defendants were confined one day in jail in the Eastern District of Louisiana.

THE LACEY ACT.

[35 Stat., 1137.]

Twenty-six cases were reported to the Department of Justice. At the close of the preceding fiscal year 26 cases were pending, of which 13 were closed during the fiscal year, 8 by convictions and the imposition of fines and the remainder by dismissal.

Of the 26 cases reported during the year, 10 were closed; 9 by convictions and the imposition of fines and 1 by the entering of a nolle prosequi. Twenty-nine cases were pending at the close of the year.

Fines were imposed as follows:

Fines imposed under the Lacey Act.

Number of cases.	Amount of fine.	Total.	Number of cases.	Amount of fine.	Total.
1	\$2	\$2	1	\$100	\$100
1	20	20	1	150	150
4	25	100	1	200	200
2	35	70	1	1,000	1,000
4	50	200			
1	75	75	17	-----	1,917

In addition to the fines imposed, defendants were compelled to pay substantial costs.

BIRD RESERVATION TRESPASS LAW.

[35 Stat., 1104.]

Six cases were reported to the Department of Justice. At the close of the preceding fiscal year 17 cases were pending, of which six were closed during this fiscal year, five by convictions and the imposition of fines, and one by trial to the jury and verdict of not guilty.

Of the six cases reported during the year one was closed, a jury trial resulting in the acquittal of the defendant. Sixteen cases were pending at the close of the year. Fines were imposed as follows:

Fines imposed under the bird reserves trespass law.

Number of cases.	Amount of fines.	Total.
1	\$5	\$5
1	10	10
3	100	300
5	-----	315

UNITED STATES COTTON FUTURES ACT.

[39 Stat., 476.]

Assistance was given the Bureau of Markets in the preparation of suggested amendments to the act. These amendments, with slight modifications, were enacted as part of section 6 of the wheat guaranty law (Public, No. 348, 65th Cong.). Aid was rendered the Bureau of Markets in the preparation of regulations under section 5 of the act as amended. A representative of this office was detailed to New York and New Orleans to assist in the inauguration of cotton classification work at these places under the amended act and regulations.

thereunder. The office participated in the consideration of 493 disputes under the act, involving 29,303 bales of cotton, the total costs assessed amounting to \$9,066.68. Several of the disputes involved the preparation or review of letters and the holding of oral hearings.

Other services of the office under this act are referred to in the summary.

UNITED STATES GRAIN STANDARDS ACT.

[39 Stat., 482.]

Assistance was given the Bureau of Markets in the preparation of standards for oats and tentative standards for rice. Hearings were held in 15 markets in connection with the oats standards. Aid was given in the preparation of a suggested amendment to section 7 of the act and in the preparation of five amendments to the regulations. Consideration was given to a general revision of the regulations and several conferences were attended in reference to publication of findings under section 5 of the act.

The records in 6,651 appeals and 9 disputes involving the grading of shelled corn, wheat, and oats under the act were reviewed, the total costs assessed amounting to \$7,540.26. Examination was made of 65 forms of inspection certificates submitted by licensed inspectors, together with incidental correspondence. Consideration was given to the suspension of 21, the revocation of 2, and the cancellation of 37 licenses of inspectors under the act, and related correspondence, orders, and other papers were reviewed or prepared. Consideration was given to 119 possible violations of the act, of which 4 were reported to the Attorney General for prosecution, and findings of fact were published in 3. In proceedings against inspectors and in alleged violations of the act by shippers, records were reviewed and notices and letters were prepared upon request of the Bureau of Markets.

Various opinions on questions arising in the administration of the act and the regulations were prepared, revised, or approved, and 14 Service and Regulatory Announcements and various bulletins of the Bureau of Markets containing opinions and information relative to the act were examined and changes suggested when necessary.

The third semiannual publication required by the act of certain facts reported by licensed inspectors and furnished by grain warehousemen were passed upon.

Other services of the office under this act are referred to in the summary.

UNITED STATES WAREHOUSE ACT.

[39 Stat., 486.]

In cooperation with the Bureau of Markets and after conferences with trade representatives, a draft of proposed regulations for grain warehouses was prepared and a series of 16 public hearings held, at which the proposed regulations were discussed and criticism invited.

Aid was rendered in the preparation of proposed amendments to the act and in the preparation of an amendment to the regulations

for cotton warehouses. Consideration was given to a general revision of the regulations for cotton warehouses.

Assistance was given the Bureau of Markets in investigations in seven markets relative to the probable effect of the operation in those markets of cotton warehouses under the act and regulations.

The office reviewed for legal sufficiency 20 records of applications for cotton warehouse licenses and 43 records of applications for licenses to classify or weight cotton, and assisted in the preparation of eight forms for use in the administration of the act and the regulations.

STANDARD CONTAINER ACT.

[39 Stat., 673.]

In addition to the various general legal matters under the act that were referred to this office for attention, one apparent violation of the act was referred to the Attorney General, with a recommendation that criminal proceedings be instituted. Defendant pleaded guilty and was fined \$25.

FOOD-CONTROL ACT.

[40 Stat., 276.]

Other items of work under this act not mentioned in the summary were the following:

After an extended investigation and hearing, a fertilizer company was ordered by the Secretary to "desist and refrain from selling or offering for sale within the United States" a certain article "under any form or representation that it has a distinct value as a fertilizer or is equal or superior to the usual and well-recognized kinds of commercial fertilizer."

Considerable assistance was given to the Bureau of Markets relative to matters growing out of the licensing of stockyard operators and others handling or dealing in live stock in connection with stockyards. Members of this office attended conferences relative to stockyards' matters in general, including conferences with live-stock market supervisors at Chicago, Ill., and Omaha, Nebr. Charges against 11 licensees under the presidential proclamation were prepared or reviewed. A number of oral hearings were held and two licenses revoked.

Assistance was given to the administrative heads of the department relative to various matters arising under the proclamation of the President licensing the farm-equipment industry. Assistance was given to the defense of a Bureau of Markets' employee against whom an action had been brought by reason of his activities in his official capacity.

FOOD-PRODUCTION ACT.

[40 Stat., 273.]

Aid was furnished in the preparation of schedules for food and other surveys, together with incidental orders under section 2 of the act.

After preliminary correspondence and conferences, recommendation was made to the Attorney General for prosecution of a firm for its failure to fill out and return the food schedules as requested. When proceedings were about to be instituted the firm filled out and returned the schedules and the department recommended that the case be dismissed.

MISCELLANEOUS WORK FOR THE BUREAU OF MARKETS.

Various letters, memoranda, news items, manuscripts, Service and Regulatory Announcements, and proofs of bulletins relating to the work of the Bureau of Markets were prepared, approved, or revised. Questions relating to the conduct of cooperative work between State agencies and the department relative to marketing and other activities were considered in conferences and correspondence. Alleged excessive prices charged for thrashing in certain districts in the Northwestern States were considered. Protests of the Spanish, Portuguese, and French Governments against the then proposed wartime prohibition legislation were considered. Aid was given in the consideration of a controversy in New York City relative to the proper disposal of city garbage and of questions arising out of alleged unfair practices of several broom-corn dealers. Assistance was given the bureau in the preparation of a report on the investigation of grain-marketing practices in Chicago and Minneapolis.

PATENTS.

Thirty applications for letters patent on inventions of employees of the department for dedication to the public were prepared and filed. During the year 35 were allowed and 22 disallowed.

The following table shows the status of applications on June 30, 1919:

Patents applied for by members of the department.

Applicant.	Bureau.	Invention.	Disposition of application.
Frank F. Chase.....	Plant Industry.....	Gravity fruit separator.....	Allowed.
Marion Dorset and Howard J. Shore.	Animal Industry.....	Process for the manufacture of concentrated hog-cholera antitoxin.	Pending in interference.
Herbert C. Gore.....	Chemistry.....	Process for preserving fruit juices	Allowed.
Chas. S. Reeves, Provost Hubbard, and Richard H. Lewis.	Public Roads and Rural Engineering.	Process for preparing waterproof paving material.	Pending in interference.
John H. Clack.....	Forest Service.....	Pack frame.....	Allowed.
Ralph B. Adams.....	do.....	Portable telephone.....	Disallowed.
Albert R. Merz, Wm. R. Ross, and John N. Carothers.	Soils.....	Method for the recovery of phosphorous fumes evolved in the volatilization method of treating phosphate rock.	Allowed.
Wm. B. Osborne, jr.....	Forest Service.....	Device for locating the range of distant objects.	Do.
James E. Imrie.....	do.....	Dry kilns.....	Disallowed.
Albert R. Merz and Wm. R. Ross.	Soils.....	Process for the extraction of potash and alumina from alunite.	Do.
Harry D. Gibbs.....	Chemistry.....	Oxidizing the side chains of aromatic hydrocarbons.	Allowed.
Robert E. Prince and Otto Kress.	Forest Service.....	Process for fireproofing paper....	Disallowed.
John R. Carothers and Wm. R. Ross.	Soils.....	Smelting of phosphate rock.....	Do.
Logan Waller Page.....	Public Roads and Rural Engineering.	Concrete.....	Do.
Harry D. Gibbs and Courtney Conover.	Chemistry.....	Process for the manufacture of phthalac anhydride, etc.	Allowed.

Patents applied for by members of the department—Continued.

Applicant.	Bureau.	Invention.	Disposition of application.
Clyde H. Teesdale.....	Forest Service.....	Process of treating wood.....	Allowed.
Norman DeW. Betts and Harry D. Tiemann.	.....do.....	Dry kilns.....	Do.
Victor M. Cone.....	Public Roads and Rural Engineering.	Venturi measuring flumes.....	Disallowed.
J. F. Collins.....	Plant Industry.....	Method of filling cavities made by excavating the decayed or injured spots in a living tree.	Allowed.
Harry D. Gibbs and Geo. A. Geiger.	Chemistry.....	Process for manufacturing side chain chlorine derivatives of toluol.	Do.
Martin N. Straughn.....	.....do.....	Process for the preservation of fruit juices.	Disallowed.
Satoaki Ozaki.....	.....do.....	Process for preparing a rice-food product.	Do.
Albert R. Merz and Wm. R. Ross.	Soils.....	Process for the simultaneous production of volatile acids and phosphate salts.	Do.
James E. Imrie.....	Forest Service.....	Improvement in shrinkage take-up frames for edge stacking lumber.	Do.
Harry D. Gibbs and Courtney Conover.	Chemistry.....	Process for the manufacture of phthalic anhydride, etc.	Allowed.
Do.....	.....do.....	Process for the manufacture of anthraquinone.	Do.
Do.....	.....do.....	.....do.....	Do.
Wm. G. Taggart.....	.....do.....	Method of manufacturing decolorizing carbon.	Pending in interference.
Robert F. Gardiner.....	Soils.....	Process of making a mixed phosphatic and nitrogenous fertilizer.	Allowed.
Frederick T. Bioletti.....	.....do.....	Process of canning or bottling ripe olives or other pickles.	Disallowed.
Elmer Johnson.....	Public Roads and Rural Engineering.	Fire-extinguisher spray nozzles..	Allowed.
Wm. H. Waggaman, Cary R. Wagner, and Harry Bryan.	Soils.....	Process for the manufacture of phosphorous, phosphoric acid, and compounds of the same.	Do.
Albert R. Merz.....	.....do.....	Process for rendering water-soluble the potash in cement mill dust.	Disallowed.
Jos. A. Ambler and Harry D. Gibbs.	Chemistry.....	Process for the manufacture of aromatic sulphonic acids.	Allowed.
J. A. Ambler, R. Hellbach, and H. D. Gibbs.	.....do.....	Apparatus for the manufacture of sulphonic acids of the aromatic carbons.	Disallowed.
J. A. Ambler and H. D. Gibbs.	.....do.....	Process for the manufacture of naphthalene sulphonic acids.	Pending.
Sherburne B. Henning.....	Forest Service.....	Process for manufacturing glue..	Case sent to War Department.
G. Archie Russell.....	Plant Industry.....	Tree trimming and harvesting machines.	Pending.
George R. Goergens.....	Publications.....	Process for a new and useful improvement in motion-picture cameras.	Allowed.
Alvin O. Lundell.....	Animal Industry.....	Meat handling and inspection machine.	Do.
J. A. Newlin, L. J. Markwardt, and A. Elmendorf.	Forest Service.....	Airplane struts.....	Case sent to War Department.
J. W. McLane.....	Plant Industry.....	Process for preparing dried sweet corn.	Allowed.
Courtney Conover and H. D. Gibbs.	Chemistry.....	Process for the purification of crude anhydride.	Do.
Elmer Johnson.....	Public Roads and Rural Engineering.	Improvements in powder-dusting machines.	Do.
J. J. Laing and C. W. Boling	Forest Service.....	Nonconducting and waterproof composition.	Disallowed.
Do.....	.....do.....	Method of manufacturing non-conducting and waterproof compounds.	Do.
F. B. La Forge.....	Chemistry.....	Manufacture of a product suitable for use as a feed for stock.	Do.
Do.....	.....do.....	Process of manufacturing glucose	Allowed.
Do.....	.....do.....	Process of manufacturing gulonic lactone.	Do.
Do.....	.....do.....	New leavening agent.	Do.
Do.....	.....do.....	Process of manufacturing an adhesive material.	Do.
Edward L. Sechrist.....	Entomology.....	Septum for honeycomb.....	Do.
C. S. Hudson.....	Chemistry.....	Process of manufacturing glucose	Disallowed.
Do.....	.....do.....	Process of manufacturing a leavening agent.	Do.

Patents applied for by members of the department—Continued.

Applicant.	Bureau.	Invention.	Disposition of application.
E. H. Siegler.....	Entomology.....	Improved insect trap.....	Allowed.
Robert F. Gardiner.....	Soils.....	Process for the production of an available phosphoric anhydride and potash fertilizer.	Do.
Martin N. Straughn.....	Chemistry.....	Process for the manufacture of preserves and jams.	Disallowed.
J. N. Carothers and W. H. Ross.....	Soils.....	Direct preparation of crystallized phosphoric acid.	Allowed.
George R. Goergens.....	Publications.....	Panoramic camera attachment..	Pending.
Bohart and Gibbs.....	Chemistry.....	Manufacture of hydrochloric acid.	Do.
F. W. Zerban.....	States Relations Service.	Manufacture of decolorizing carbon from kelp.	Allowed.
Yoder and Langley.....	Plant Industry.....	Cane-stripping comb.....	Pending.
Robert F. Gardiner.....	Soils.....	Manufacture of nitric acid.	Disallowed.
Ambler, Lubs, and Gibbs..	Chemistry.....	Manufacture of Cymene sulphonic acid.	Pending.
W. T. Conway.....	Animal Industry.....	Hog scraper.....	Disallowed.
R. N. Harger.....	Plant Industry.....	Manufacture of N-methyl p-ammonia phenol.	Allowed.
J. N. Carothers.....	Soils.....	Manufacture of nitrogen fertilizer	Pending.
R. F. Gardiner.....	do.....	Manufacture of synthetic ammonia.	Do.
H. D. Gibbs.....	Chemistry.....	Process of sublimation.....	Do.
Laing and Boling.....	Forest Service.....	Waterproof composition.....	Allowed.
H. D. Gibbs.....	Chemistry.....	Process of purifying anthracene press cake.	Pending.
Wise and Adams.....	do.....	Photographic sensitizing dyes...	Do.
H. C. Gore.....	do.....	New sirup.....	Allowed.
Gibbs and Ambler.....	do.....	Benzene sulphonic acid.....	Pending.
G. E. Sanders.....	Entomology.....	New insecticide.....	Do.
K. P. Munroe.....	Chemistry.....	Adhesive.....	Do.
Adams and Wise.....	do.....	Photographic sensitizing dyes...	Do.
Ambler and Gibbs.....	do.....	Aromatic sulphonic acids.....	Do.
Davis and Bryan.....	Soils.....	Production of ammonia.....	Do.
Gibbs, Ambler, Colton, and Senseman.	Chemistry.....	Sulphonic acid compounds.....	Do.
C. Conover.....	do.....	Apparatus for controlling reactions between gases.	Do.
Do.....	do.....	do.....	Do.
E. G. Beinhart.....	Plant Industry.....	Curing tobacco.....	Do.
R. F. Gardiner.....	Soils.....	Synthetic ammonia.....	Do.
F. Daniels.....	do.....	Ammonium nitrate.....	Do.
C. G. Bates.....	Forest Service.....	Atmometer.....	Do.
L. Weisberg.....	Chemistry.....	Acetic anhydride.....	Do.
W. H. Waggaman.....	Soils.....	Phosphorus and phosphorus acid.	Do.
H. C. Gore.....	Chemistry.....	Dextrin.....	Do.



REPORT OF THE INSECTICIDE AND FUNGICIDE BOARD.

UNITED STATES DEPARTMENT OF AGRICULTURE,
INSECTICIDE AND FUNGICIDE BOARD,
Washington, D. C., August 22, 1919.

SIR: I have the honor to submit herewith a report on the work of the Insecticide and Fungicide Board for the fiscal year ended June 30, 1919.

Respectfully,

J. K. HAYWOOD,
Chairman of Board.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

This board was inaugurated to assist the Secretary of Agriculture in the enforcement of the insecticide act of 1910. The purpose of this act is to prevent the manufacture, sale, or transportation of adulterated or misbranded Paris greens, lead arsenates, and other insecticides, and also fungicides (including disinfectants), and for regulating traffic therein. The act has been in effect since January 1, 1911, and its enforcement has had a markedly salutary effect upon the composition and labeling of articles subject to its provisions.

The industry affected by this act is constantly increasing in size and importance, and numerous new manufacturers are being brought to our attention. For the most part, the board has found that the trade is in sympathy with the enforcement of this law, since it tends to discourage illegitimate competition and to increase the confidence of the consuming public in articles subject to its provisions, which, upon being used by the public, fulfill the claims made on the labels.

The great increase in the use of insecticides and fungicides, caused to some extent by the campaign inaugurated to increase the quantity of food produced, and also by the progress of science, resulting in the discovery of new and more effective methods of combating destructive insects and diseases of plants and animals, has necessitated constant vigilance and has resulted in a material increase in the amount of work which the board has been called upon to perform.

The activities of this board have a very far reaching effect. When it is considered that all food-producing crops (grains, vegetables, and fruits), all food-producing animals (cattle, hogs, and sheep), and the great cotton and tobacco crops are all subject to the ravages of destructive insects and diseases and that the growers are dependent, to a large extent, for their control upon the use of proper insecticides and fungicides, it will be realized that the proper enforcement of this law affects every individual in the Nation. The disinfectants and

insecticides used in the home and public places are also subject to the provisions of this law, so that the food we eat, the clothes we wear, and the homes we live in have all been affected by the enforcement of this act. The campaign of the Bureau of Animal Industry to control the cattle tick has also resulted in an increased consumption of insecticides for that purpose, and this has necessitated increased activity on the part of this board.

Investigations made by the board revealed the fact that ground daisy flowers were being used to a considerable extent to adulterate insect powder. A campaign made during the year against insect powder adulterated with powdered daisies resulted in the seizure of shipments of the article and recommending a number of cases for prosecution. The campaign against misbranded and adulterated disinfectants has been continued, and the board has acted on a comparatively large number of disinfectant cases. During the year special attention has been given to Bordeaux mixtures and Bordeaux lead mixtures which were recommended on the label for use at too great a dilution to secure effective fungicidal control. Many cases involving such faulty claims were either disposed of by correspondence with the manufacturers or reported for prosecution. The recent discovery of a remedy for the cotton boll-weevil has opened up a tremendous new field for the use of insecticides. A campaign was inaugurated during the last part of the fiscal year, in collaboration with the Bureau of Entomology, to assure the delivery to farmers of the South who use calcium arsenate for cotton boll-weevil control, of calcium arsenate that will control the weevil and at the same time will not injure the cotton plant.

During the fiscal year 1918-19 a tendency was observed in the direction of increased adulteration or misbranding of certain materials which, before this time, were for the most part shipped in conformity with the provisions of the insecticide act. Investigations indicated that this increase was due largely to careless errors in manufacture, caused by the employment of inexperienced and low-grade labor, and to manufacturers changing their formulas without changing their labels, such changes in formulas being made because manufacturers could not obtain all the basic materials commonly used in their preparations or could obtain them only at a prohibitive figure. It was also noted that a relatively large percentage of the goods of certain new manufacturers was adulterated or misbranded. This is probably due to inexperience on the part of the manufacturer in properly controlling his manufacturing operations and inexperience in the branding of insecticides.

By reason of the enlarged market and the consequent growth of the industry, and the increased tendency toward adulteration and misbranding, there should be a considerable expansion of the work of the board, which can be secured only by the employment of more inspectors, scientists, and clerks than it is possible to employ with the present appropriation.

INTERSTATE SAMPLES.

During the fiscal year the board reported to the solicitor of the department 104 cases presenting alleged violations of law with recommendations that the facts be transmitted to the Attorney

General to institute criminal action or seizure proceedings. Disposition was made of 129 cases by correspondence with the manufacturers. These cases presented violations which were technical only, not flagrant, or cases in which the manufacturer gave reasonable and adequate explanation of his failure to conform to the provisions of the act. Action was taken to place in abeyance 621 samples, which, upon examination and test, were shown to be in compliance with the provisions of the law or were from shipments of the same goods made prior to shipments for which the manufacturer had been convicted and had after citation conformed to the requirements of the law. On June 30, 1919, 73 cases were pending preliminary hearings or before the board for final action, 136 were held in temporary abeyance pending the receipt of further information, or the outcome of prosecutions based on the same product, or correspondence with the manufacturers, and 471 samples were undergoing analysis and test.

The inspectors and sample collectors of the board, operating throughout the United States, collected 904 samples during the year. A general classification of the articles represented in the collection is as follows:

Interstate samples collected.

Class of samples.	Number of samples.
Arsenate of calcium.....	39
Arsenate of lead.....	96
Bordeaux mixture and combinations of Bordeaux mixture with insecticides.....	118
Chlorinated lime.....	20
Dips for animals.....	21
Disinfectants, germicides, bactericides.....	93
Fly preparations, for animals.....	18
Fish-oil and whale-oil preparations.....	29
Formaldehyde preparations.....	16
Insect preparations, household use.....	82
Insecticide and fungicide preparations, agricultural use.....	80
Kerosene emulsions.....	10
Lice and mite killers.....	41
Lime-sulphur solution and sulphur preparations.....	38
Nicotine preparations.....	3
Paris green.....	49
Pyrethrum and hellebore powders.....	77
Miscellaneous.....	74

IMPORT SAMPLES.

During the year 41 official and unofficial import samples of insecticides and fungicides were collected by the various port laboratories of the Bureau of Chemistry for examination and test by the board. Disposition was made of 43 samples; one official sample was found adulterated and misbranded, and it was recommended that the consignment be released when correctly labeled. Two official samples were found to be neither adulterated nor misbranded and the shipments were accordingly released. The remaining samples were unofficial, 15 of them being found to be adulterated or misbranded, or both, and in these cases it was recommended that future shipments be detained, while 25 were neither adulterated nor misbranded.

SPECIAL INVESTIGATIONS.

The investigations begun some time ago to discover a chemical method to determine stems in insect powder, determine reasonable standards for insect powder, and study the process of manufacture of insect powder and composition of raw materials, as well as the finished product, have been completed and a bulletin giving the results has been prepared for publication.

Results of the chemical analyses of several hundred authentic samples of insect flowers, stems, and powders are given in the bulletin, on the basis of which permissible amounts of sand and stems in insect powder have been determined and issued in Service and Regulatory Announcements No. 22.

Service and Regulatory Announcements No. 21, giving information relative to the various new State insecticide and fungicide laws, was issued during the year. This publication supplements Service and Regulatory Announcements No. 13, issued September 13, 1916.

A bulletin (U. S. Department of Agriculture Bulletin 795) entitled "The Adulteration of Insect Powder with Powdered Daisy Flowers," was prepared by scientists of the Board in collaboration with the Bureau of Chemistry and published by that Bureau. In this bulletin it is shown that a chemical analysis is insufficient to show adulteration of insect powder with daisy flowers. It is further shown that the adulteration of insect powder with daisy flowers can be definitely determined by microscopic examination, and the distinguishing characteristics of powdered daisy flowers are outlined.

During the year a bulletin (U. S. Department of Agriculture Bulletin 750) was issued in collaboration with the Bureau of Chemistry, entitled "A Method of Preparing a Commercial Grade of Calcium Arsenate." This bulletin embodies the results of experiments made to determine the best method for preparing a grade of calcium arsenate on a commercial scale.

Chemists of the board have made various basic investigations relative to the composition and properties of various calcium arsenates. The results of these investigations are being collated with the idea of publication for the benefit of the public.

Aside from the routine work of testing the efficacy of proprietary fungicides, the plant pathologists of the board working in cooperation with the Bureau of Plant Industry have continued and enlarged the investigations relative to the practical value of several types of fungicides, and considerable information and more conclusive data have been obtained. These investigations involve studies in respect to the efficacy of dusting mixtures for use in controlling various plant diseases; a study of the relative values of the various types of sulphur compounds, such as the sodium polysulphids and calcium polysulphids; studies of the effect of combining different types of arsenicals, such as lead arsenate and calcium arsenate, on the fungicidal value and injurious properties of these sulphur compounds; and a comparative study of the results of tests with Bordeaux mixture containing various amounts of copper to obtain data concerning the amount of copper necessary in commercial Bordeaux mixture to insure satisfactory control of certain plant diseases. Laboratory methods for the study of fungicides relative to their action against

fungi have been further developed and have been used to great advantage as a quick means of detecting certain worthless fungicides and also for the detection of active and inert ingredients of various types of fungicides. Laboratory studies of the physical properties of the various commercial Bordeaux mixtures, and also of home-made mixtures as affected by various methods of preparation, were made, and considerable information for use in the enforcement of the act has been gained concerning this subject.

During the year the entomologists of the board have completed an extensive study of the value of naphthalene as a remedy against chicken lice, and a paper entitled "Naphthalene Against Chicken Lice" has been accepted for publication in an entomological journal.

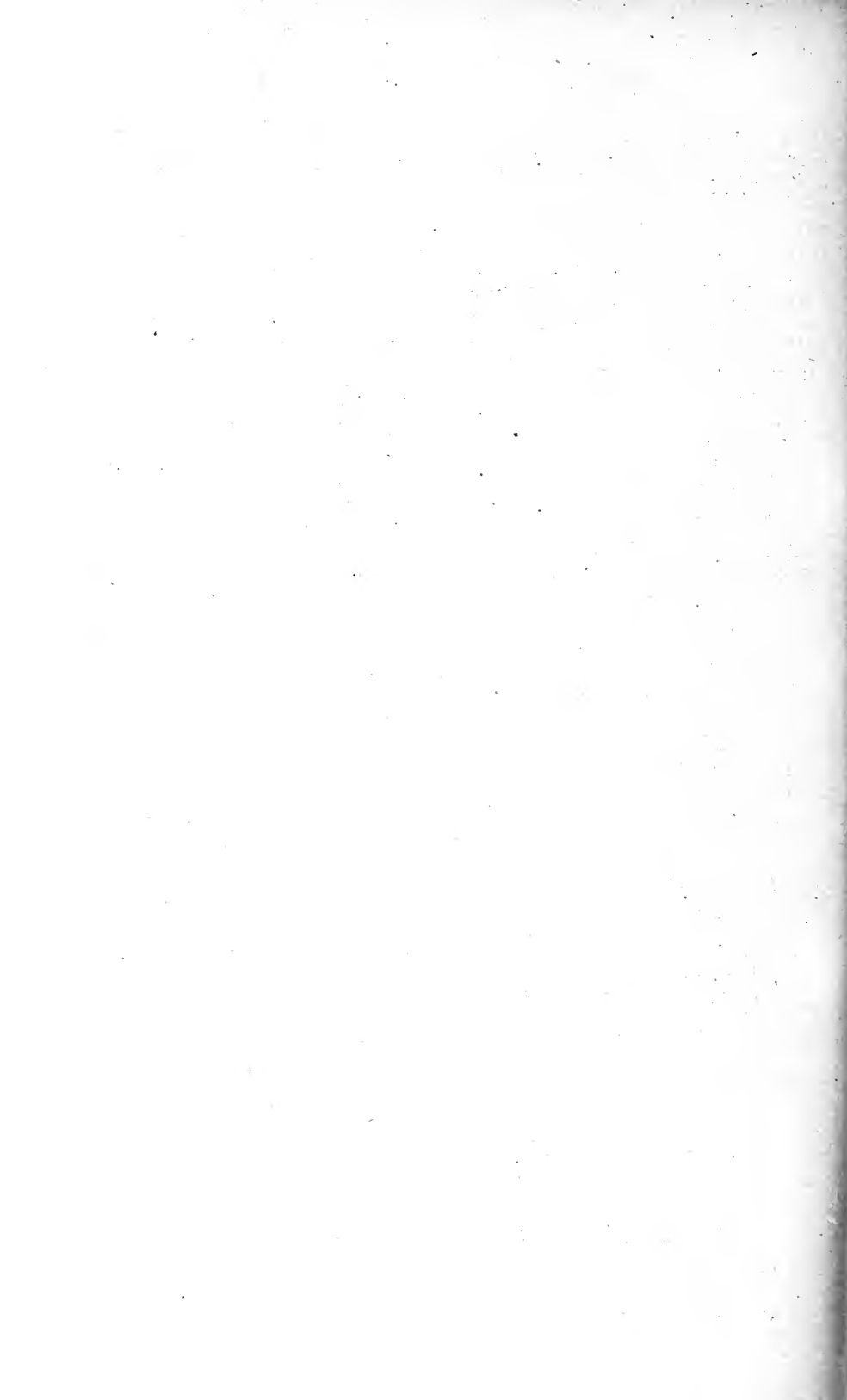
The special studies of proprietary remedies to be used against chicken lice, chicken mites, and dog fleas, and the action of various substances on these insects, were continued during the year. It is planned to publish a paper on this subject during the present year. A considerable amount of work has also been done on the coal-tar disinfectants to determine the dilution at which they will be effective against various insects, and with pyrethrum stems to determine whether they possess any insecticidal value.

The entomologists of the board, in collaboration with the Bureau of Entomology, have conducted field tests with various dust mixtures, with special reference to amounts to apply, different combinations and time of application, and the resultant effects on insects and action on foliage. Much work along the same line is planned for the future. Extensive field tests have also been made to determine the value of dry or powdered substitutes for liquid lime sulphur. Information of much value in connection with the enforcement of the act was obtained.

The scientists of the board, working under the direction of the Bureau of Animal Industry, have made investigations relative to the state of water in cresol compounds, which are used as insecticides and fungicides. These investigations were proposed to establish the fact on physical chemical grounds that water was an inert ingredient in these compounds.

In connection with the zoological division of the Bureau of Animal Industry, investigations relative to the effect of carbon bisulphid as a remedy for bots and worms infesting horses have led to conclusions which warrant giving advice to manufacturers relative to the labeling of products designed to stop infestations by these parasites.

A special study of apparatus for quantitative analysis by sublimation led to a new form of apparatus for this method of analysis, a description of which is being prepared for publication.



REPORT OF THE FEDERAL HORTICULTURAL BOARD.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FEDERAL HORTICULTURAL BOARD,
Washington, D. C., October 1, 1919.

SIR: I submit herewith an executive report covering the administration of the plant quarantine act for the fiscal year ended June 30, 1919.

Respectfully,

C. L. MARLATT,
Chairman of Board.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

LINES OF WORK.

The activities under the Federal plant quarantine act which continue from year to year are the enforcement of the miscellaneous foreign and domestic quarantines and other restrictive orders listed at the end of this report. Several of these have been promulgated during the fiscal year 1919. Another important field of work of the board is in the administration of special appropriations made by Congress for the control or extermination of newly established important plant enemies. The board also cooperates with the Bureaus of Entomology and Plant Industry in the enforcement of quarantine provisions in relation to appropriations made to these bureaus for similar subjects of plant pest control.

The general organization of the work of the board, except for the necessary enlargements, remains the same as last year. Port inspection offices are now maintained at Boston, New York, Newark, San Francisco, Seattle, Calexico, and all the border ports between Mexico and Texas, and at New Orleans. An effort has been made to meet the occasional needs at other border ports by cooperation with State officials or special details of inspectors. This service is very inadequate, however, and should be greatly strengthened. The board has continued its cooperative relations with the State, Treasury, and Post Office Departments of the Federal Government, and with the State inspection and other officials. The number of such State officials appointed as collaborators of the department to assist in the board's work has been considerably increased.

The more important of these activities of the board are discussed in some detail in the following pages.

THE PINK BOLLWORM.

REVIEW OF THE WORK IN TEXAS.

The work in Texas and elsewhere in the South in relation to the pink bollworm has been, as hitherto, under the field direction of Dr.

W. D. Hunter, a member of the board, and in charge of Southern Field Crop Insect Investigations for the Bureau of Entomology. The report of last year gave a comprehensive review of the pink bollworm situation up to October, 1918. The review of the work of the last fiscal year, for convenience, takes up separately, the consideration of the conditions and crop of 1918 and of 1919, respectively.

INSPECTION AND CLEAN-UP ACTIVITIES WITH RESPECT TO THE CROP OF 1918.

The principal work of last fall and winter, extending late into the spring of this year, was in the nature of field inspections and clean-up operations, including both the volunteer cotton in the quarantine zones and the illegally planted fields in zone No. 2. All such illegally grown cotton was fully controlled as to the crop produced, including the prompt crushing of the seed and the export to foreign countries of the lint. This control was carried out under a form of agreement between the State department of agriculture of Texas and the planters of outlaw cotton, but the actual control was administered by agents of the board.

In the course of all this work no instance of reinfestation by the pink bollworm was found in any of the old areas of invasion.

THE PINK BOLLWORM APPEARS IN WESTERN TEXAS.

Late in 1918 the pink bollworm was discovered in two areas in western Texas, namely, in the Great Bend of the Rio Grande River, and in the Pecos Valley in the region of Barstow, Tex. The infestation of these two areas evidently had a common origin, namely, from seed or seed cotton smuggled across the Rio Grande River in the region of the Great Bend.

The Pecos Valley infestation was traced to some of this smuggled seed cotton which had been carted from the Great Bend district to a gin at Barstow, Tex. This infestation later was found to have extended from Barstow to the region of the town of Pecos, involving seven localities, and presented a serious situation, in that the insect was here brought into a district where cotton is commercially grown on a fairly large scale. Fortunately the infestation was limited to comparatively few fields.

The infestation in the Great Bend of the Rio Grande was scattered over a distance of 150 miles between Candelaria and Boquillas. This Great Bend district is not a cotton country, and the growth of this fiber is limited to a few scattered fields along the river in small valleys at the base of the mountains, representing altogether only a few hundred acres. The infestation here appears to have resulted from an original infestation on the Mexican side of the river opposite Candelaria from planting seed brought by immigrant farmers from the Laguna district of Mexico. Part of the spread along this district may have been due to water carriage from infested fields on either side of the river.

Immediately on the discovery of these new points of infestation active work was undertaken to exterminate the insect along the lines which had been so successfully followed in eastern Texas, both with respect to cleaning the cotton fields and the safeguarding of the crop

of seed and lint of 1918. In the meantime an intensive survey was made of the entire Rio Grande and Pecos Valley districts without the location of other infested cotton.

The clean-up operations in the Rio Grande Valley were comparatively simple on account of the small acreage. The similar operations in the Pecos Valley assumed considerable proportions and involved at times a labor force of from 500 to 1,000 persons. In this work cooperation was secured with the War Department to the extent of the loaning by that department of considerable equipment for the housing of labor, the available equipment which had been accumulated by the board in the previous year's work in southeastern Texas not being sufficient for the needs. The farmers also cooperated very heartily in this work, and other labor was obtained from El Paso and like near-by sources. The infestation in the Pecos region was very slight, less than a score of larvæ being found altogether. To be on the safe side, however, the area cleaned was extended well beyond the outer infested points, involving perhaps altogether in the Pecos Valley nearly 5,000 acres.

Neither of these new regions presented the same risk to the cotton industry of the South as did the outbreak in eastern Texas, on account of their remoteness from other areas of cotton culture. In view of this fact and, as applying to the Pecos district, the consideration that alfalfa—the only other dependable crop in this district—could not be successfully established in the spring of 1919, a plan was devised permitting the planting of cotton in the Pecos district for 1919 under what seemed to be fully adequate safeguards. The cotton seed for planting of the 1919 crop was obtained from uninfested districts and the crop of this year has been and will be under the full control of the State and Federal authorities. The planters have agreed to the further condition that after 1919 this district shall become a strictly noncotton zone for such period as may be determined to be necessary.

A noncotton zone was immediately established for the Great Bend district of the Rio Grande. This action was taken on account of the known infestation on the Mexican side of the river and the probability that otherwise Mexican cotton would be smuggled across, which it would be impossible later to distinguish from cotton grown on the American side.

GROWTH OF COTTON PERMITTED IN THE QUARANTINED ZONE OF EASTERN TEXAS.

With respect to the proclaimed noncotton zones in eastern Texas of 1918, a plan of agreement was entered into for the planting of cotton in these districts under strict State and Federal supervision. The planters in this region were very insistent that they should be allowed to plant cotton under suitable precautions. The fact that the great majority of the planters in these areas had cooperated heartily in the enforcement of the noncotton restrictions in 1918, and the further fact that no infestation by the pink bollworm had been discovered throughout that year in any of the volunteer cotton or in the illegally planted fields, led the State authorities, after consultation with this department, to devise a plan for the planting of cotton in these areas, other than the zone on the Mexican border. In addition to the control which the State will exercise over the crop—crushing all seed and foreign export of lint—such planters entered into an agreement to

permit any radical steps which may be necessary to exterminate any outbreak which may result from such planting.

INSPECTION ACTIVITIES DURING THE GROWING SEASON OF 1919.

An important feature of the work during the spring and summer of 1919 has been the following up of all clues of possible distribution of Mexican cotton lint to mills in cotton-growing areas of the South prior to the quarantine of 1916. The tracing of this cotton has covered not only the original sale of such cotton but all resales and also all distributions of picker waste or motes from mills in which such cotton was utilized. This and similar inspection work has extended from the Carolinas, where several thousand bales of Mexican cotton were purchased and utilized just prior to 1916, through the other cotton States to Arizona, where there has been and is danger of infestation by carriage of seed by Mexican laborers. The cotton fields in all such districts surrounding mills or in other situations where risk had been determined have been given repeated inspections throughout the season. The bulk of this work has naturally been in Texas, where particular attention has been paid to the localities in eastern Texas infested in 1916 and 1917 and in the vicinity of the 12 mills which received Mexican cotton seed in 1916. The Pecos Valley crop of this year, and the cotton planted under State and Federal control in the former quarantined districts in eastern Texas also have been given frequent and intensive inspections.

THE PINK BOLLWORM APPARENTLY EXTERMINATED.

As a result of all this inspection activity, both as to quarantined and regulated districts in Texas and as to all other points of possible infestation throughout the cotton area of the United States, no evidences whatever of the pink bollworm have been determined this year. This is a most encouraging result and indicates the probability of a successful outcome of this tremendous effort to control an important foreign pest after it had become fairly widely and firmly established. This outcome has been made possible by the fact that the insect is substantially limited to one food plant grown under cultivation and in the western districts wholly under irrigation. Undoubtedly certain temperature conditions of the winter of 1918 and 1919 unfavorable to the insect have aided in obtaining this result. One adverse feature may be noted, namely, the failure of the authorities of the State of Texas to enforce fully the prohibition of the growth of cotton this year in the Great Bend district of the Rio Grande. One hundred acres of cotton were planted in this district by a grower, and in spite of urgent recommendations made by this department this field has been left to mature. Undoubtedly this crop can be safeguarded, but it will make more difficult the enforcement of noncotton zones in the future.

USE OF AEROPLANE IN SURVEY WORK.

That it is possible to use the aeroplane in a practical way in the cotton survey work, and particularly for the location of cotton fields which might otherwise escape detection, was demonstrated during

1918 and 1919 in the cotton inspection and control work in Texas. This activity was made possible by an active interest and cooperation on the part of the War Department. Competent pilots and aeroplanes were loaned for this work, which was prosecuted for over a year with great success and was particularly valuable in the scouting work necessary along the long stretches of the Rio Grande, where roads and other means of transportation are poor or insufficient. A preliminary use of the aeroplane had, however, been made the year before, which had resulted in the discovery of some fields in the wooded and sparsely settled portion of a quarantined district which had been theretofore overlooked. The following officials of the Aviation Service of the Signal Corps of the Army have been assigned from time to time to this work: Second Lieut. Harold Compere and Second Lieut. William H. Tillisch. The expert inspectors of the board associated with this work as observers have been H. S. Hensley, Carl Heinrich, and E. L. Diven.

This work was terminated August 7, 1919, as the result of an accidental fall of the aeroplane in which both the pilot, Lieut. Tillisch, and the observer, Mr. Diven, lost their lives. Although these flights had been conducted over a long period without serious accident, the danger of the service was fully recognized. Both Lieut. Tillisch and Mr. Diven were men of high character and undertook the work with a full realization of its dangers. Lieut. Tillisch, who could have been discharged from the War Department, remained in its service on account of his interest in this new use of the aeroplane. The greatest honor is due these men for their courage and devotion to a service which unfortunately involves the highest personal risk. They may be considered the pioneers in this country in the use of the aeroplane in a practical way in relation to agriculture.

A NEW TEXAS PINK BOLLWORM ACT.

On March 10, 1919, a new pink bollworm law was enacted by the State of Texas and made immediately effective. This act is a revision of the previous act. Its principal new feature is the provision for the establishment of zones or districts in which the growing of cotton may be permitted under regulation, the immediate object being to permit the growth of cotton under restrictions in the old quarantined areas of eastern Texas.

This act provides for a commission of five entomologists to determine the necessity for the establishment of quarantine areas within the State of Texas. The members of the commission as now created under the terms of the act are: Ernest E. Scholl, designated by the commissioner of agriculture; W. D. Hunter, designated by the Federal Horticultural Board, United States Department of Agriculture; F. B. Paddock, designated by the Agricultural and Mechanical College of Texas; N. Hess, appointed by the governor of Texas, and an entomologist to be appointed by the county judge in the county in which the fields believed to be infested are located.

On the recommendation of this commission the necessary quarantine action has been taken by the governor under the new law with respect to the several districts in Texas which have at any time been infested by the pink bollworm and also with respect to the border noncotton zones.

The old Trinity Bay district has been declared a regulated zone by orders of March 15 and April 24. This zone includes all of the counties surrounding Trinity Bay included in the noncotton zone of 1918, except the extreme western portion, which has been released from all quarantine restrictions. This is the important cotton-producing territory bordering the Brazos River in Brazoria and Fort Bend Counties, which was included in the quarantine of 1918 merely as an additional safeguard.

The territory actually infested in 1917 in the small Hearne district has been continued as a noncotton zone by an order dated April 24. Furthermore, cotton grown within a radius of 3 miles of such zone is brought under regulation by another order of the governor of the same date.

By orders dated April 9, 1919, the governor of Texas has reissued under the new act the old border noncotton zone, including Maverick, Kinney, and Valverde Counties, and has established additional quarantine zones to cover the new infested territory in western Texas. These are a noncotton zone comprising the counties of Presidio and Brewster, which include the infested territory in the Great Bend of the Rio Grande, and a special zone comprising the counties of Ward and Reeves to include the infested territory of the Brazos River. Supplementing the latter special zone, two proclamations were issued by the governor of Texas under date of May 1, 1919, establishing regulated zones covering all territory within 5 miles of and including the fields in Ward and Reeves Counties which were determined as infested with the pink bollworm as to the crop of 1918.

After a conference with the Federal authorities cooperating with the State of Texas in the pink bollworm work, regulations were issued under date of April 24, 1919, by the commissioner of agriculture of Texas, governing the planting and the safeguarding of the cotton crop produced in the three regulated zones. In other words, cotton may now be grown under regulation in all the zones established in the interior of Texas, with the exception of a small portion of the Hearne zone, and the growth of cotton is prohibited in two border zones involving the Great Bend district and the old border noncotton zone of last year, including the counties of Maverick, Kinney, and Valverde.

THE PINK BOLLWORM IN MEXICO.

The survey and inspection of the cotton grown near the border of Mexico adjacent to the United States has been continued, covering the more important areas between Brownsville and Eagle Pass, Tex. No new infestation has actually been found anywhere near the border in this portion of Mexico. One locality, however, at Guerrero, 9 miles from the Texas border, opposite the town of Zapata, is under suspicion because of the determination that certain fields at that place were planted from seed obtained from an infested locality in Mexico. This planting has a special importance from the fact that a stream of considerable size flowing from this district discharges into the Rio Grande not far above extensive cotton cultures in both Mexico and the United States, and therefore may ultimately be the means of conveying the insect to these cultures.

The only new infestations determined in Mexico are the scattered fields opposite Candelaria, in the Great Bend district, already noted.

Until conditions in Mexico materially improve there seems to be little likelihood of any serious effort being made on the part of the Mexican Government or planters to eliminate cotton culture in the Laguna or other infested regions and to take steps similar to those taken in Texas to exterminate the insect. No wide survey of Mexican cotton growing is possible under existing political conditions.

The research work conducted at the Lerdo station in the Laguna has been maintained throughout the year with very satisfactory results. Some forty to fifty thousand larvæ were collected in the fall of 1918 for winter, spring, and early summer observation and experimentation. It is believed that by the end of this season the full biological data of the insect will have been worked out, so that this station can thereafter be discontinued. It is too early at this writing to determine the amount of damage which this insect has caused to this year's crop in the Laguna and elsewhere in Mexico. The loss to the crop of 1918 amounted to approximately 30 per cent, involving, as it did, much of what would have been the second and third pickings. From 100 bolls picked at random in late September were taken 920 larvæ. The normal yield of the Laguna is very high, and even with this reduction a profitable crop was secured.

The practical control experiments carried out in cooperation with leading planters in the Laguna have indicated the possibility of a large reduction of loss by cultural methods; namely, fall cleaning and destruction of old plants and the replanting with clean seed. This is substantially the control system now practiced in Egypt and is possible under such low labor cost as obtains in Egypt and in Mexico. Under the labor scale in the United States the intensive clean-up methods required would be almost prohibitive in cost.

The important phases of the work in the Laguna have been (1) a continuation of life-history studies of the insect; (2) the determination of the importance of alternative food plants, such as okra and possible native Mexican and Texas malvaceous plants related to cotton—a considerable quantity of seeds of these plants having been collected in Texas, and the plants are now being grown in the Laguna for the purpose of this experiment; (3) determination of control possibilities by poisoning and by cultural methods; (4) determination of the amount of damage throughout the season; and (5) the determination of the extent of natural distribution and of the possibilities of distribution through the agency of irrigation canals.

With respect to alternative food plants this work has shown that Hibiscus and other plants closely related to cotton may serve as hosts for the pink bollworm, but has fully demonstrated the fact that cotton is much the favored host plant. In this connection studies of the last two years have indicated that under conditions obtaining generally in Texas cotton is practically the sole food plant of the insect.

TEXAS BORDER QUARANTINE SERVICE.

The Texas border inspection and quarantine service to prevent the movement of cotton and cottonseed into the United States has been continued actively during the year under the general direction of Mr. R. Kent Beattie. The volume of the work has necessitated a

considerable increase in the number of inspectors. The car fumigation houses referred to in the previous report have been completed. An increase of \$100,000 was granted by Congress in the appropriation for the Mexican border work to cover the cost of the chemicals and labor involved in the disinfection of railway cars and freight in these specially constructed fumigation houses. To cover this cost the Secretary of Agriculture is authorized to fix charges for such cleaning and disinfection, the moneys thus received to be covered into the Treasury as miscellaneous receipts. Delays in securing equipment and installation of the machinery designed for the generation of the hydrocyanic-acid gas have prevented the inauguration of this new form of disinfection, and in the meantime the disinfection and cleaning by the older methods have been carried out under the supervision of the department's inspectors. From the 1st of October the disinfection along the border will be in these houses under the direct supervision of the inspectors of this department.

The inspectors of the board at the border ports of Mexico have the additional duty of enforcing the various quarantines which affect Mexican products other than cotton, and to facilitate this work a warning placard to passengers was issued by the Secretary of Agriculture under date of August 10, 1918, calling attention to the prohibitions affecting the entry from Mexico of various fruits, sugar cane, nursery stock, and sweet and Irish potatoes, in addition to cotton, cotton seed, and cottonseed products.

Inspection forces were maintained at Brownsville, Laredo, Eagle Pass, El Paso, and Del Rio, Tex. At the first four points mentioned railroad lines cross the border. At these points all the cars and freight offered for entry into the United States were inspected and passed for entry if free from cotton seed or lint. In the great majority of cases these cars were also fumigated with hydrocyanic-acid gas under the direction of the inspectors immediately upon their crossing into the United States. During the year 16,597 cars were passed for entry at these four ports. About 43 per cent of these cars were empties, 14 per cent contained ore, 12 per cent hides, 1 per cent scrap iron, 1 per cent bones, and the rest contained miscellaneous cargoes invoiced under 46 different headings.

No railroad crosses the border at Del Rio, but the existence of an infested area in Mexico, in the immediate vicinity of this port, made necessary the inspection and cleaning of vehicles here, to the number of about 175 per week.

THE EUROPEAN CORN BORER.

An important European crop pest now designated in this country as the European corn borer, but infesting many other crops, has recently gained entrance into the United States and may develop into one of our most injurious insects. The increase of our knowledge of the distribution and of the plants attacked in the United States by this pest has been very rapid, and the board has conducted three hearings and one conference on the subject and has participated in several field surveys of the regions infested in cooperation with experts of the Bureau of Entomology and State officials.

MEANS OF INTRODUCTION AND SPREAD.

The European corn borer was discovered late in 1917 as an enemy of corn in the vicinity of Boston, Mass., in what was believed at that time to be a rather limited area of perhaps 100 square miles. Hemp straw which had been imported from Europe and utilized in the vicinity of Boston some years before for rope making was then thought to have been the means of introducing this insect. From present information, it seems much more probable that the insect was introduced about nine years ago with large importations of Hungarian broom corn to meet the then existing shortage in the United States of this crop. Of this imported broom corn, some hundreds of tons were utilized for broom making in Boston and like quantities went to New York, Kentucky, and other points in the Middle West. The later discovery of the further spread of this insect in the United States seems to correspond closely with the distribution of this imported broom corn. For example, late in 1918, the insect was found to have invaded the Mohawk Valley for a considerable distance, extending from the neighborhood of Albany, N. Y., some 25 or 30 miles up the Mohawk Valley and northward nearly to Saratoga Springs. At the upper part of this district a very large quantity of this imported broom corn had been utilized in a local broom factory.

The distribution of this insect as now known covers an area of over 1,200 square miles about Boston, touching the border of New Hampshire and involving two towns in that State. Another considerable outlying point in Massachusetts, involving four towns, was determined in August of this year, 65 miles distant from Boston, at the base of Cape Cod Peninsula. The Albany area in New York has been considerably extended. Two new points of invasion have been determined in New York State: one on the east side of the Hudson River, opposite Albany, and the other 200 miles farther west in extreme western New York. A similar point of infestation has also been determined in Erie County, Pa. These last two areas were discovered in late September, 1919. These wide extensions of the insect indicate the need of a thorough-going survey of the northeastern quarter of the United States, and especially such districts as those in Kentucky and in the upper Ohio Valley which are known to have received greater or less quantities of imported broom corn about the same time that it went to Massachusetts and New York. These surveys are now (October) in progress.

FOOD PLANTS IN THE UNITED STATES.

While this insect has been designated as the European corn borer, it infests, as already noted, many other plants, such as most annuals, including common grasses, small grains, most garden vegetables, and weeds; in fact, almost any plant which is not of a hard or woody nature. The fact that this insect is an internal feeder, working in almost any part of the plant and even penetrating the base of plants beneath the ground, together with the almost unlimited number of plants in which it can develop, makes any determination of its actual spread in the United States practically impossible, and this has an important bearing on questions of quarantine or possible future extermination.

NATURE AND AMOUNT OF DAMAGE.

Present experience with it in this country would seem to indicate that corn is its favorite food plant. Its work on certain garden vegetables and truck crops other than corn has caused no economic losses to such crops, or only trifling losses, and is significant only as indicating that some of these may be the means of spreading the insect.

In the relation of this insect to corn, there are, fortunately, some hopeful features. It develops from the experience of this year that it is double-brooded in Massachusetts and single-brooded in New York, owing to differences in climate. As a single-brooded insect in New York, its damage to corn has been negligible as reflected in the crop. In Massachusetts, even with the large numbers resulting from the second brood, its damage has seldom exceeded 10 per cent of the ears and in most fields in the invaded districts much less than this. Even the injury to such ears has been as a rule not greater than that produced by the ordinary corn ear-worm over large areas of the United States where the latter insect is an important annual pest, often infesting all or nearly all ears of corn. The highest damage in Massachusetts has represented about 25 or 30 per cent of the ears, and this has been in isolated fields surrounded by weedy areas more or less infested with the insect, the corn therefore in a way concentrating the insect from these surrounding sources of supply. The insect is essentially a stem or stalk borer, and apparently corn can harbor from one to several of these insects in a stalk without appreciable effect on the development of the ear. In the case of early corn, its infestation of the stalk is very apt to come after the ear is practically ready for harvest, and infestation of the stalk may increase and continue even for a considerable period after harvest.

From the experience in New York, where the insect has evidently been for about nine years, it would seem to be fully established that as a single-brooded insect it will be a negligible factor in relation to corn production, and this is especially emphasized by the fact that the crop of the New York district is almost altogether of the small flint corn which in New England has been notably susceptible to damage.

In climates where the insect has two broods, as in New England, and perhaps as in the South, the possibilities of damage are much greater. With respect to these possibilities, however, it should be noted that the few patches of large-stalked vigorous field corn such as characterizes the great corn belt of the United States, grown in the invaded areas in Massachusetts as a part of the department's experiments and by farmers, have shown an almost complete immunity from serious infestation by this insect. It remains to be determined, therefore, whether this insect will actually develop into a real menace to the great corn crop of the United States. That much harm can be done by this insect where it is double-brooded, as in New England, to sweet corn and to such dwarf corn as the flint varieties commonly cropped in the upper limits of the corn belt of the United States, seems to be demonstrated. In regions where such corn is grown, however, the insect will undoubtedly be generally single-brooded. Immediately about Boston the climate is apparently made more favorable to the insect by ocean currents.

STATE AND FEDERAL CONTROL WORK.

Following the determination by the Massachusetts authorities of the establishment of this insect in that State and the efforts on the part of the department of agriculture of that State to cope with the insect, the Federal Government was called upon to assist the State authorities by establishing a Federal quarantine and by aiding in control and, if possible, exterminative work. In response to this request, following a formal hearing on the subject, a quarantine was promulgated, effective August 1, 1918, covering the then known infested area in Massachusetts and prohibiting the movement therefrom interstate of corn fodder and cornstalks, whether used for packing or otherwise, and green corn, roasting ears, corn on the cob, or corncobs.

The discovery of the new important areas in New York in the fall of 1918 was followed by a second hearing, February 26, 1919, for the purpose of bringing within the scope of this quarantine this newly discovered infested territory. As a result of this hearing it was decided to defer taking additional Federal quarantine action until a more accurate determination had been made of the spread of the insect. This decision was based on the fact that both of the infested areas were entirely within the States involved, and on the definite understanding which was expressly given by the representatives of these two States that effective quarantine control would be exercised over the infested districts within their borders so that there would be no possibility of interstate movement of infested products. Quarantine orders were shortly thereafter issued by the commissioners of agriculture of New York and Massachusetts covering the invaded areas in each of these States. The Massachusetts order was based on a new quarantine law enacted by that State April 11, 1919, having particular reference to the European corn borer. The Massachusetts order issued under date of May 1, 1919, prohibited the movement from any point within the areas infested by the corn borer surrounding Boston of the corn and corn products enumerated in the Federal quarantine. The New York order prohibited movement from any point of the area infested with the European corn borer in that State to any point outside of the quarantined area of corn and also of a large series of truck plants and ornamental and flowering plants. Both of these States made appropriations which ultimately amounted to \$100,000 each for the cleaning up of the infested cornfields. The enforcement of these State quarantines was co-operated in by the Federal authorities.

In view of the further spread of this insect in Massachusetts and elsewhere and the large number of food plants which in New England had not been brought under control by the State quarantine, a third hearing on the subject of this corn borer was conducted August 15, 1919. This hearing was held at the statehouse, Boston, to give opportunity for local truck growers and commission merchants who would be largely affected by the quarantine to participate in the discussions. It was apparent from the information developed at this hearing that the territory invaded by this insect in Massachusetts, and perhaps elsewhere in New England and in New York, was so inadequately determined as to make a quarantine covering merely the area then known to be invaded in these two States thor-

oughly impracticable and useless, and that any quarantine in respect to this insect to be of value and at all efficient must include New England and New York as a whole. Such quarantine, if established, could be graded with respect to the areas known to be infested as opposed to the areas not known to be infested. It was manifested also that the restrictions should cover not only corn, but all other articles of common commerce for food purposes, such as spinach, celery, beans, beets, etc., which have been shown to be capable of carrying the insect. This determination as to the area to be covered was further shown to be necessary by the fact that much of New England is dependent for its important elements of food supplies on the products of the infested area, and the representatives of the surrounding States were not willing to have these sources of food shut off. A quarantine taking in the area as a whole, therefore, would leave opportunity for the normal movement of food within the quarantined area to meet the needs of the summer and native populations of these States.

The rapid development of the knowledge of the distribution of the insect has served to withhold action on a further Federal quarantine until the results of the fairly wide survey which is now in progress shall be available.

The work with respect to this insect as now planned under the Bureau of Entomology in cooperation with this board has for its object: First, the determination of the present distribution of the insect as a basis for quarantine and other control measures; and, second, a demonstration on a large scale of such control measures. The area to be surveyed is large, including New England, New York, and in a general way all the States east of the Mississippi. The object of the proposed control experiments is to determine whether such control looking even to extermination is feasible and practicable under the conditions of infestation as they are seen in both Massachusetts and New York. In the meantime tests will be continued to determine the possibilities of damage which this insect may have to the coarser and stronger kinds of field corn which represent the predominating elements of the corn crop of the United States.

For the prosecution of the work for control and enforcement of the quarantine against this pest, Congress was asked last year for an appropriation of \$500,000. Of this sum, \$250,000 was granted by Congress and became available July 24, 1919. This fund, assigned to the Bureau of Entomology, is now being used by that bureau in carrying out the program of work just outlined, in cooperation with the board as to quarantine matters.

The exploitation which has been given to this insect and the unwarranted forecasts of future losses from it have led to widespread fears of damage to the corn crop of the country. These fears were reflected in a called meeting of the National Association of Commissioners of Agriculture, held at Albany, N. Y., and Boston, Mass., on August 28 and 29, respectively, of this year. The outcome of this meeting was a series of resolutions urging Congress to appropriate \$2,000,000 to carry on the corn-borer work. The department's views with respect to the immediate and future needs for the purpose of carrying out the program described is that an additional appropriation at this time of \$500,000 will enable this department fully to determine the status of the pest as an enemy of corn and other crops,

its present distribution, and the possibilities of control, and that larger appropriations, if they are to be made, should await the determination of these fundamental features of the problem.

THE JAPANESE BEETLE.

The Japanese beetle, reported to be one of the most injurious insects in Japan, was apparently introduced seven or eight years ago in the vicinity of Riverton, N. J., in soil with imported Iris roots. When this insect had increased sufficiently to attract notice it had thoroughly established itself over some 600 acres and at present covers perhaps 10,000 acres, with outlying points of infestation involving approximately 25,000 acres. The Japanese beetle is a general feeder, attacking the grape, peach, plum, apple, and cherry, as well as many ornamental plants and weeds and various truck crops, such as sweet potato, and especially sweet corn. In the case of corn the beetle penetrates the tips of the ears, working in very much the same way as the common ear worm, and as it remains in these ears for an indefinite period, it is possible to transmit it widely with shipments of green corn to various markets.

Following the discovery of possibilities of wide harm to various agricultural products, a hearing on the subject of this pest was conducted, and a quarantine was shortly thereafter promulgated covering the territory more or less invaded by this insect, namely, the townships of Delran, Chester, and Cinnaminson, county of Burlington, N. J. Inasmuch as the probable sole export from these townships of plants which would be the means of conveying the insect is sweet corn, the quarantine prohibits the movement interstate from the quarantined district of green sweet or sugar corn other than in accordance with the rules and regulations drawn under the quarantine to protect such movement.

In the enforcement of this quarantine and in the campaign looking to the eradication of the insect authorized by Congress the board is cooperating with the Bureau of Entomology of this department and with the officials of the State of New Jersey.

THE POTATO WART IN THE UNITED STATES.

The fact that the European potato wart disease had secured foothold in the United States was announced in the annual report of the board for last year. The disease was discovered in September of 1918, subsequent to the period covered by that report but prior to its publication. At that time the disease seemed to be restricted to three counties in eastern Pennsylvania, namely, Luzerne, Schuylkill, and Carbon Counties, involving house gardens in some 26 mining towns in these counties. It was apparent that the disease had originated from the shipment into Pennsylvania of about 12 carloads of European potatoes of inferior quality in 1912, before the passage of the Federal plant quarantine act of August 20 of that year. This act specifically provided for an immediate quarantine against the countries infested with the potato wart, and subsequent to the passage of this act no importations of potatoes have been made from countries where the wart disease is known to exist.

In view of the menace of this disease to the potato crop of America, a special fund of \$50,000 was appropriated by Congress for the fiscal

year 1920 to enable the Secretary of Agriculture to effect the extermination of this disease in Pennsylvania or elsewhere in the United States in cooperation with the State or States concerned. Under this appropriation the board is actively cooperating with the State of Pennsylvania in the control of this disease, and particularly in a country-wide survey of the potato crop to determine the possible occurrence of the disease in other places. Over 3,000,000 bushels of European potatoes entered the port of New York in 1911 and 1912, and other smaller shipments arrived at other ports. It is impossible to trace in detail the distribution of these importations, but enough information has been secured to show that they were widely distributed, going as far south as Florida and Texas and as far west as Nebraska, with possibilities of some movement to the Pacific coast. In view of this situation, a very extended survey has been conducted during the last two months (August and September, 1919), following the potato crop from the South northward in cooperation with the experts of the various States concerned. By full publicity and the cooperation of county agents, boys' and girls' clubs, and other available agencies, these surveys have been made much more comprehensive than the available funds would have made possible otherwise. This survey has been especially intensive in all mining and industrial districts, it being realized that the appearance of this disease in the important potato-growing sections would be very promptly reported, but that it might remain hidden and concealed in the districts where the growth of potatoes was limited to garden cultures.

Up to the end of September this survey had been carried as far north as West Virginia, and these States and Pennsylvania, New York, and the New England States are still under examination. As a result of this survey this disease has been located in new districts in Pennsylvania and has been found also in West Virginia. In Pennsylvania the disease has been determined in three separate localities in Cambria County in southwestern Pennsylvania. This is in a bituminous coal-mining section. In the meantime the inspectors of the State of Pennsylvania have somewhat extended the limits of the infestation in the old area in the eastern part of the State. In West Virginia the wart has been found in one garden in Randolph County and in about 10 gardens in Tucker County. The infested area in Tucker County is again a mining area, while the infested area in Randolph County is in a section which is being developed as a potato-growing region and particularly as a source of "certified stock."

In the Rocky Mountain and Pacific Coast States an educational campaign has been undertaken, no garden-to-garden search being attempted.

A hearing was held January 28, 1919, with respect to a domestic quarantine on account of this disease, but in view of the fact that the area was limited and was at that time entirely within the State of Pennsylvania, and that this State was undertaking active quarantine and other control operations, a Federal quarantine did not seem to be needed and has not been promulgated.

The most important immediate step is the further determination of the spread of this disease and of its importance as a potato pest to this country. Such determination of spread must be made before

it is practicable to consider the promulgation of a Federal quarantine.

One very hopeful feature, however, has appeared in the work of this year, namely, that several of the most important potato varieties grown in this country are apparently immune to the disease. This is especially true of the Irish Cobbler and the Rose 4.

The danger of immediate spread of the disease is very much reduced by the fact that there is no important commercial potato production in the invaded districts. The infestation, however, has manifested itself in a very severe form, practically destroying the entire crop in many of the affected gardens.

The importance of a study of the potato wart conditions in England, Scotland, Wales, and Ireland, so as to be able to take immediate advantage, in the work in this country, of any effective control methods, either from the use of immune varieties of potatoes or through cultural operations which have been developed in the many years of experience with this disease in these foreign countries, led the board to make such investigation in Great Britain and Ireland. This work was carried out for the board, in cooperation with the State of Pennsylvania, by Mr. J. G. Sanders, Director of the Bureau of Plant Industry of the Pennsylvania State Department of Agriculture, who is collaborating with this board in the control of the potato wart outbreak in Pennsylvania. It has resulted in the securing of information which will be of much advantage to the work in this country. One of the results is the proposed introduction of certain varieties of potatoes which are believed to be immune to the disease and which have marked color characteristics, enabling them to be easily distinguished from other potatoes, with the object of utilizing them for planting in the invaded districts in lieu of actually prohibiting potato culture in such districts. Prohibition of potato culture would lead to wide dissatisfaction on the part of the miners and other inhabitants of these districts, mostly of foreign nationalities, who would hardly understand and appreciate the need of such strict quarantine measures. The Bureau of Plant Industry of the Department of Agriculture is planning, in cooperation with the board, to introduce a considerable series of these and other British potatoes which have been demonstrated to be substantially free from any or serious damage from this disease. These varieties will be obtained from regions in the countries concerned which are believed to be free from the disease and will be utilized, through the experimental period, only in districts in this country where the disease is already established. This phase of the investigation assumes great importance in view of the known wide distribution of the European importations of 1911 and 1912 and the considerable number of new points of infestation determined for the disease during the year, indicating a possibility that the disease may be so widespread that it may not now be possible to effect its eradication in this country.

THE FLAG SMUT AND TAKE-ALL DISEASES.

In response to representations made to the board by the Bureau of Plant Industry as to the risk from two important diseases, namely, the flag smut and take-all, affecting wheat and other cereals in

foreign countries, a hearing on the subject of these two diseases was held March 25, 1919. It was pointed out in the notice of hearing that the take-all disease was widely prevalent in Australia and reported to occur also in Italy, France, Belgium, Great Britain, Ireland, and Brazil. The flag smut disease was known to exist in Australia and also in India and Japan. The flag smut is a disease of wheat. The take-all disease may infest, in addition to wheat, oats, barley, rye, and rice.

The flag smut affects the leaf blades, leaf sheaths, stems, and sometimes the spikes of wheat. Usually every shoot is affected, the leaves wither, and the spike is frequently replaced by a mass of twisted leaves. The spores are carried on the seed and live over in the soil. In portions of Australia the losses from this disease run from one-tenth to one-half of the crop.

The take-all disease, known also as whitehead or foot rot, attacks the roots and the bases of the plants, rotting the roots and blackening the base of the stem. Young wheat plants speedily wither and die; older ones may survive but rarely produce grain. Heavy losses have been sustained in all countries where this disease occurs.

The risk of introduction of these two diseases was largely from the possible importation of any of the grains mentioned for seed purposes. War conditions, however, had led to some commercial importations of wheat from Australia and there was a possibility of further commercial shipments from this source on account of the large accumulations of wheat in that country.

The hearing on this subject brought out rather distinctly the need of controlling the entry of foreign wheat, either for food or for planting purposes. The promulgation of the quarantine was postponed pending the determination of the practicability of disinfecting wheat from the countries under consideration as a basis for fixing the restrictions which would be placed upon the entry of such wheat. On the completion of this inquiry the quarantine was promulgated July 2, 1919, effective August 15, 1919, with regulations governing the issuance of permits, sterilization, and other conditions of entry. This quarantine prohibits the importation of seed or paddy rice, but places no restriction on the importation of husked or polished rice imported for food purposes.

THE FLAG SMUT AND TAKE-ALL DISEASES IN THE UNITED STATES.

While the steps described were being taken with respect to the control of the entry of foreign wheat, these two diseases, flag smut and take-all, were discovered to be already present in southern Illinois and the take-all disease in Indiana, the evidence seeming to indicate that they had been in southern Illinois for two or three years. The source of entry of these diseases into this country has not been determined, but it is believed to have been through some importation of seed wheat from Australia or other foreign country. This discovery was followed up by an intensive investigation of the principal wheat-growing areas of the United States in which the board cooperated with the Bureau of Plant Industry and with the officials of the several States concerned. These field investigations failed to demonstrate the occurrence of these diseases at that time at any other points, and this situa-

tion as to infestation remained unchanged until September 18, 1919, when the disease was apparently definitely determined as existing in Roanoke County, Va.

As soon as the survey had been substantially completed a public hearing as a basis for a domestic quarantine on account of these two diseases was held at the Department of Agriculture, July 15, 1919. The subjects of the hearing were thoroughly discussed by a large attendance of State officials, grain dealers' and millers' associations, and as a result of the information obtained—which indicated that the States concerned had ample legal powers to take the necessary steps to control the diseases and to prevent the interstate movement of diseased products, and that in the case of Indiana such measures had already been instituted—the department deemed it unnecessary at that time to establish a Federal quarantine. The State of Illinois very promptly thereafter instituted control measures.

The enforcement of these control measures is being carried out by these two States under the advice and with the active cooperation of the Federal Horticultural Board and the Bureau of Plant Industry of this department. Similar control action is being taken in connection with the outbreak in Virginia. These measures include the burning of the straw and stubble, the disinfection of the wheat and of the thrashing machinery involved, and the elimination of the growth of wheat in the infected areas for a period of years. It is believed that by these means the spread of the diseases from these States will be prevented in so far as it is possible to accomplish this result by quarantine and control operations.

In the meantime a thorough survey is being kept up throughout the United States in cooperation with the State authorities for the determination of any other possible footholds of these diseases. It is believed that the foreign quarantine referred to at the outset will prevent any further entry of these diseases into the United States.

THE BLACK STEM RUST OF WHEAT.

The board has actively cooperated with the Bureau of Plant Industry in the campaign to secure the eradication of the common barberry, with the object of controlling the black wheat stem rust. The barberry has been demonstrated to be an important factor in the development of serious wheat rust epidemics. The losses from this disease are limited very largely to the northern wheat-producing States and are unimportant in the Southern States. The object wished, therefore, was to effect the extermination of the common barberry in such Northern States and by quarantine prohibit its movement into such States from other States. Pending the determination of the feasibility of such quarantine action, the board undertook to effect this general purpose by an agreement to be entered into by nurserymen and others interested. A circular letter describing the need, accompanied with a pledge card, was sent out April 4, 1918, and more than 2,000 nurserymen signed these pledges and thus voluntarily put into effect what was substantially a complete quarantine as to the movement of the common barberry into the region to be protected. The effectiveness of this voluntary quarantine showed the general practicability of such control, and to give it

a greater efficiency, after a stated public hearing, February 24, 1919, a quarantine was issued April 15, 1919, effective May 1, 1919. This quarantine points out that the susceptible varieties of barberry and the related Mahonias have been very largely eradicated from the States of Nebraska, Iowa, Illinois, Indiana, Ohio, North Dakota, South Dakota, Minnesota, Montana, Wisconsin, Michigan, Wyoming, and Colorado and therefore quarantines all the other States of the United States, including the District of Columbia, and orders that no plants of the species of *Berberis* and *Mahonia* enumerated in the quarantine shall be moved or allowed to move to points outside of the quarantined areas.

This quarantine places no restriction on the movement of the Japanese barberry and the Japanese Mahonia, the most valuable and most commonly planted of the barberries and Mahonias, and which are not alternate hosts of the disease.

COTTON IMPORTATIONS.

The restrictions placed on the entry of foreign raw cotton, cotton waste, cotton wrappings, and cotton seed and cottonseed products, to prevent the entry of the pink bollworm and other dangerous cotton pests, are being continued.

The entry of foreign cottons and of such cotton waste and cotton wrappings as must be fumigated as a condition of entry is limited to the ports of Boston, New York, San Francisco, and Seattle, where fumigating plants for this purpose have been provided. The entry of cotton waste and cotton wrappings for which disinfection is not required is permitted at any port where the board maintains inspection service.

The importation of foreign cotton was considerably reduced during the year as a result of war conditions, amounting to a total of only 179,537 bales. The cotton indicated in the tables given below as from the United States represents returned American cotton, and that indicated from Calexico, Mexico, is cotton permitted entry from the Imperial Valley, Lower California. These two items were entered without requirement of disinfection or other restrictions.

The entry of cotton waste comes in two classes, restricted and unrestricted, the former requiring disinfection and subsequent control as to utilization the same as foreign cottons. Manufactured waste from which all cotton seeds have been removed and waste from American cotton may be entered under permit without the requirement of disinfection or other restrictions. Some 415 bales of waste were entered after disinfection. Some 15,000 bales were entered without disinfection. The latter represents very largely American cotton waste which was purchased for utilization in Canada for war purposes and resold and returned to the United States at the close of hostilities.

The restrictions on the entry of cotton wrappings or bagging are necessitated by the fact that such wrappings carry considerable quantities of cotton and cotton seed, and therefore must be subjected to restrictions similar to those applying to the entry of cotton. During the year 24,236 bales of bagging entered the United States. Of this amount 2,277 bales were fumigated and the balance were permitted

entry without fumigation. The latter represented, for the most part, American cotton bagging returned to the United States after the utilization in foreign countries of the American cotton.

Foreign cotton seed is permitted entry only through the port of Callexico and from cotton grown in the Imperial Valley, Lower California. The restrictions on the entry of cottonseed cake and meal are due to the fact that such products frequently carry uncrushed cotton seeds. The entry of cottonseed oil is not restricted except as to its entry from Mexico. Cottonseed oil from Mexico is permitted entry only when the oil originates in mills in the Laguna District. Upon the entry of such oil at border ports of Mexico are placed certain restrictions intended to prevent the entry with the oil carriers of cotton seed and cotton insects.

The following tables indicate respectively the number of bales of cotton, cotton waste, and burlap, and the quantities of cotton seed and cottonseed products imported during the fiscal year.

Cotton imported during the year ended June 30, 1919.

[By port of entry and country of origin.]

Country.	Boston.	New York.	San Francisco.	Seattle.	Providence.	Callexico.	Detroit.	Total.
	Bales.	Bales.	Bales.	Bales.	Bales.	Bales.	Bales.	Bales.
Chile.....		2						2
China.....		4,962	2,264	2,872				10,098
Dominican Republic.....		327						327
Ecuador.....		261						261
Egypt.....	61,107	1,289						62,396
Haiti.....		10,128						10,128
India.....		3,908						3,908
Mexico.....						54,791		54,791
Nicaragua.....		33						33
Peru.....		35,791						35,791
Turks Island.....		12						12
United States.....	1,183	372			163		65	1,730
Total.....	62,295	57,085	2,264	2,872	163	54,791	65	179,537

Cotton waste imported during the year ended June 30, 1919.

[By country of origin and port of entry; all figures represent running bales.]

Port.	Canada.	England.	Japan.	Mexico.	Spain.	United States.	Total.
Boston.....	570					137	707
New York.....			80		119	407	606
Philadelphia.....		206				465	671
Seattle.....			449				449
Niagara Falls.....						7,301	7,301
Laredo.....				100			100
Chicago.....						4,335	4,335
Ogdensburg.....						126	126
Rouses Point.....						20	20
Detroit.....						1,085	1,085
Total.....	570	206	529	100	119	13,936	15,460

Bagging imported during the year ended June 30, 1919.

[By country and port.]

Country.	New York.	Boston.	Philadelphia.	Detroit.	Total.
	<i>Bales.</i>	<i>Bales.</i>	<i>Bales.</i>	<i>Bales.</i>	<i>Bales.</i>
Canada.....	267	2,459	147	58	2,931
England.....	3,261	2,048	5,695		11,004
France.....	8,541				8,541
Scotland.....		68			68
Spain.....	1,396		250		1,646
United States.....		46			46
Total.....	13,465	4,621	6,092	58	24,236

Cotton seed and cottonseed products imported during the year ended June 30, 1919.

Port.	Cotton seed.	Cotton-seed cake.	Cotton-seed meal.	Cotton-seed oil.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Gallons</i>
Calexico.....	12,677			
Eagle Pass.....		19,220		147,582
Laredo.....		1,139		132,000
New York.....			1,578	
San Francisco.....		2,071		
Seattle.....		1,709		
Total.....	12,677	24,139	1,578	279,582

NURSERY STOCK, PLANT, AND SEED IMPORTATIONS.

The need of additional restrictions or prohibitions with respect to the entry of various classes of nursery stock and other plants and seeds was referred to in the report of the Federal Horticultural Board for last year, and also the holding of a public hearing at this department on May 28, 1918, at which the whole subject was fully discussed with all the interests concerned.

Following the hearing the subject was further studied by the experts of the Bureau of Plant Industry of the department, including a field examination of the conditions throughout the country, to determine the essential needs as to future plant importations. The results of these extended investigations were embodied in a tentative plant quarantine order which was sent, August 29, 1918, to plant trade journals and related societies, and to individuals who had manifested an interest in this subject, either by attending the hearing or by correspondence, with the request that the proposed quarantine be given careful consideration, with a view to a conference later to discuss and determine the desirability of the proposed restrictions. This conference was held October 18, 1918, and the quarantine was amended in minor details and promulgated by the department November 18, 1918, to take effect June 1, 1919.

This quarantine with regulations supersedes on and after June 1, 1919, the regulations theretofore in force governing the importation of nursery stock and brings under restriction all other plants and plant products for or capable of propagation. Under this quarantine fruits, vegetables, cereals, and other plant products for or capable of propagation, but intended for medicinal, food, or manufacturing

purposes, and field, vegetable, and flower seeds may be imported without permit or other restrictions.

The quarantine provides further that the following classes of plants may be imported under permit and on compliance with the other requirements of the regulations, viz, certain bulbs, rose stocks, fruit stocks, including cuttings, scions, and buds, and seeds of nut, fruit, forest, and other ornamental and shade trees and of hardy perennial ornamental shrubs.

The quarantine also provides for the importation, under special permits from the Secretary of Agriculture, of limited quantities of otherwise prohibited stock for the purpose of keeping the country supplied with new varieties of plants and stock for propagation purposes, not available in the United States.

This quarantine does not affect the status of nursery stock and other plants and seeds covered by special quarantines and other restrictive orders now in force.

The regulations governing the entry of the classes of plants listed above are similar to those hitherto in force with respect to nursery stock, and take into account the classification of countries into (1) those maintaining inspection and certification of nursery stock in accordance with the requirements of the plant quarantine act, and (2) countries which have not made provision for such compliance.

Three minor amendments have been issued with respect to this quarantine. Amendment No. 1 provides for the use of sterilized soil for packing bulbs and other plants. Amendment No. 2 is a revision of regulation 14 and is essentially an interpretation of this regulation rather than an enlargement of powers under the quarantine. The entry of new varieties of plants and of necessary propagating stock which would be otherwise prohibited under the quarantine is specially provided for in this regulation. It is further provided that all such importations shall be made through the Office of Foreign Seed and Plant Introduction of the Department of Agriculture at the cost and for the use of the importer. This method of introduction is to provide for the proper inspection and safeguarding through the agency of the highly developed inspection and quarantine service now organized by this department of the material thus imported. Amendment No. 3 provides for the entry of otherwise prohibited stock from foreign countries contiguous to the United States and has special application to the entry of such stock from the Dominion of Canada. Under this regulation such entry under stated restrictions will be permitted only of specified classes of nursery stock and other plants and seeds which can be considered as peculiar to such contiguous countries and not mere reproductions of imported stock from foreign countries.

This quarantine aroused wide criticism and protest, much of this being based, however, on misrepresentation and particularly on the charge, which was directly contrary to the facts, that the quarantine would prevent the United States from receiving the new plant creations of Europe and other foreign countries and that America would therefore be forever deprived of all such additions to its horticulture and floriculture. These protests also found large support on the part of importers whose business was necessarily restricted as a result of the quarantine. On the other hand, this quarantine received substantial indorsement from the great body of the producing nurserymen of the country.

In answer to various criticisms and to correct certain misrepresentations the board has issued several explanatory memoranda and statements, the most important being a memorandum dated February 1, 1919, giving a general discussion of the quarantine and of the conditions which led to its promulgation. A further explanatory statement was issued by the Secretary of Agriculture as a result of a conference March 1 with a committee representing the New York Florists' Club, the Association of American Florists, and the American Association of Nurserymen. The statement of the Secretary is based on an impartial investigation which he had made of the whole subject—the report of which fully supported the quarantine. These two documents have been published in trade journals and used liberally in correspondence with respect to the quarantine.

The chairman of the board, on invitation, has attended during the year important annual meetings of nurserymen and florists to discuss Federal plant quarantines and particularly quarantine No. 37. These meetings included the Pacific Coast Association of Nurserymen and Ornamental Horticulturists, at Riverside, in May; the National Association of Nurserymen, in Chicago, in July; and the Society of American Florists and Ornamental Horticulturists, in Detroit, in August. The discussion at these meetings directly and through the reports published in trade journals has brought a perhaps better understanding of the fundamental purposes underlying this quarantine to the great body of persons interested throughout the United States.

COUNTRY OF ORIGIN AND NATURE OF NURSERY-STOCK IMPORTATIONS.

The following table gives the country of origin and the classes of plants and seeds imported during the year ended June 30, 1919:

Country of origin and nature of nursery-stock importations.

Country of origin.	Fruit trees.	Fruit tree stocks.	Grape-vines.	Bush fruits.	Roses.	Rose stocks.	Forest and ornamental deciduous trees.
Australia.....							
Belgian Congo.....							
Belgium.....							
Bermuda.....							1,975
Brazil.....							
Canal Zone.....							
Canada.....	318				33		700
Chile.....							
Colombia.....							
Cuba.....							
England.....	1,432		73	24	28,048	1,149,000	4,906
France.....	1,197,137	5,797,025	167	571	334,961	1,378,452	213,273
Guatemala.....							
Holland.....	4,218			5,760	126,964	256,650	255,333
Ireland.....					11,142	137,000	
Italy.....							
Japan.....	36,755	24,195			0		31,976
Leeward Island (St. Kitts).....					2		
Mexico.....							
Panama.....							
Philippine Islands.....							
Samoa.....							
Scotland.....	367		23		2,779	80,000	20
Trinidad.....							
Venezuela.....							
Total.....	1,240,227	5,821,220	263	6,355	503,938	3,001,102	508,213

Country of origin and nature of nursery-stock importations—Continued.

Country of origin.	Orna- mental deciduous shrubs.	Conifer- ous trees other than pines.	Pines.	Ever- green trees.	Ever- green shrubs.	Field grown florists' stock.	Stocks, cuttings, or seed- lings.	Tree seeds.
								<i>Pounds.</i>
Australia.....								38,236
Belgian Congo.....								150
Belgium.....	46,928	6,639		4,306	11,429	29,484		
Bermuda.....	7,075			9,325		35,509		2,451
Brazil.....						21,326		9,399
Canal Zone.....						150		
Canada.....	100			13		187	12,000	
Chile.....						8		
Colombia.....						43,740		
Cuba.....						1,800		
England.....	27,284	5,844		1,922	101,773	63,742	1,500	
France.....	1,015,527	353,253		14,236	191,743	87,209	2,364,912	4,007
Guatemala.....						5,332		
Holland.....	425,658	470,677		18,924	694,528	87,081	57,607	
Ireland.....	45			5	727	5		
Italy.....								5,009
Japan.....	31,284	7,982	645	2,427	7,118	52,633		15,233½
Leeward Island (St. Kitts).....						2		
Mexico.....						4,110		
Panama.....						9		
Philippine Islands.....						1,703		
Samoa.....						8		
Scotland.....	467	55		49	1,095	12,432	25	
Trinidad.....						17,856	30	1,059
Venezuela.....						15,090		
Total.....	1,554,368	844,500	645	51,207	1,008,413	479,421	2,436,074	75,591½

DISTRIBUTION OF IMPORTED NURSERY STOCK, BY STATES.

The following table indicates the distribution by States of nursery stock imported during the last six years:

Distribution of imported nursery stock, by States.

State.	Number of cases.					
	1918-19	1917-18	1916-17	1915-16	1914-15	1913-14
Alabama.....	38	69	173	284	241	125
Arizona.....						4
Arkansas.....		2	26	22	95	11
California.....	136	995	4,891	2,403	3,357	1,922
Colorado.....	24	11	162	152	150	152
Connecticut.....	1,002	413	801	1,972	1,372	1,432
Delaware.....	13	1	54	53	40	38
District of Columbia.....	223	44	422	491	549	562
Florida.....	9	19	200	1,466	2,461	56
Georgia.....	29	96	223	191	228	196
Illinois.....	1,060	473	2,891	4,671	3,316	3,942
Hawaii.....		10	79	57	20	4
Idaho.....			6	4	5	9
Indiana.....	144	89	464	577	569	545
Iowa.....	160	398	731	905	1,066	394
Kansas (north).....	3	15	105	55	51	48
Kansas (south).....	50	133	96	292	292	286
Kentucky.....	265	77	188	410	320	352
Louisiana.....	53	89	228	279	400	416
Maine.....	24		53	65	42	51
Maryland.....	152	154	308	595	756	558
Massachusetts.....	2,554	662	2,112	4,769	4,221	5,115
Michigan.....	272	323	910	1,325	1,562	1,232
Minnesota.....	99	91	300	746	701	528
Mississippi.....	17	17	40	21	23	35
Missouri.....	121	68	380	513	592	676
Montana.....			36	32	20	26
Nebraska.....	16	61	151	249	217	149

Distribution of imported nursery stock, by States—Continued.

State.	Number of cases.					
	1918-19	1917-18	1916-17	1915-16	1914-15	1913-14
Nevada.....					1	2
New Hampshire.....	7	2	40	44	53	57
New Jersey.....	7,668	2,369	6,860	13,295	8,829	10,458
New Mexico.....						1
New York.....	6,657	3,937	8,058	16,325	12,669	12,363
North Carolina.....	8	23	70	121	80	162
North Dakota.....	25	1	20	56	12	8
Ohio.....	1,137	1,127	2,447	3,314	3,374	3,068
Oklahoma.....	4	3	14	17	15	13
Oregon.....	137	44	326	355	480	560
Pennsylvania.....	2,941	1,282	3,638	6,096	6,556	9,309
Rhode Island.....	378	33	212	562	741	606
South Carolina.....		6	25	41	39	41
South Dakota.....	17	7	19	29	16	16
Tennessee.....	7	70	161	185	197	200
Texas.....	33	110	183	151	139	184
Utah.....	1		19	25	27	35
Vermont.....		1	17	41	24	20
Virginia.....	58	18	273	379	354	338
Washington.....	135	74	388	421	403	482
West Virginia.....	17		129	87	87	102
Wisconsin.....	104	78	429	509	430	334
Total.....	25,803	13,495	39,358	64,652	57,192	57,225

INSPECTION OF IMPORTED PLANTS AND PLANT PRODUCTS.

A record has been kept since the organization of the board of all the interceptions of foreign plant pests and diseases on imported nursery stock and other plants and plant products. As a result of the requirement of the Federal plant quarantine act as to foreign inspection and certification, practically all of the foreign countries which are doing a commercial trade of any importance in such products with the United States have installed adequate inspection service, and for the most part it is undoubted that these countries are probably giving as good inspection service as human skill and science can afford. The result of this service has been a tremendous improvement in the sanitary condition of the plants and plant products imported into the United States. The infestation has been reduced to probably as near a minimum as is humanly possible. Nevertheless, the records referred to indicate that in spite of this inspection and the foreign certifications accompanying importations, large numbers of injurious insects and plant diseases are still coming into the United States on imported plants. Inasmuch as one of the principal arguments of objectors to foreign plant quarantines is that proper inspection will eliminate these evils, it is opportune at this time to call attention to a summary of the conditions actually shown by the inspection records of the last seven years as to the plant imports from the principal exporting countries. With respect to insects, these records indicate that there have been received from Holland during this period 1,051 infested shipments, involving 148 kinds of insect pests; from Belgium, 1,306 infested shipments, involving 64 kinds of insects; from France, 347 infested shipments, involving 89 kinds of insects; from England, 154 infested shipments, involving 62 kinds of insects; from Japan, 291 infested shipments, involving 108 kinds of insects; from Germany, 12 infested shipments, involving 15 kinds of insect pests. Many of these intercepted insects are not known to be established

anywhere in this country, and numbers of them, if established, would undoubtedly become important farm, garden, or forest pests.

During the fiscal year 1919, possibly as a result of the let-down due to war conditions, there was an exceptional increase of infestation of imported nursery stock with gipsy and brown-tail moth. In the previous years under this quarantine shipments thus infested had been so reduced that for the entire period of seven years only 63 infested shipments had been discovered, whereas prior to the passage of the quarantine act such instances of infestation ran up to several thousand annually. Altogether 123 species of insects were intercepted on various plants and plant products during the fiscal year just ended. In addition to gipsy-moth egg masses and brown-tail moth nests, the more important interceptions were pink bollworm-infested cotton seed from Brazil and China, European Lackey moth from Holland, fruit fly larvæ from Cuba, Oriental moth from Japan, gold-tail moth from France, seed weevils infesting cherry seed from France, and a number of injurious scale insects on miscellaneous plants. Soil insects were collected on several occasions, including the European mole cricket, earwigs, Otiorehynchid larvæ, wire worms, and white grubs from Holland.

With respect to plant diseases intercepted during the fiscal year 1919, 270 distinct disease organisms were identified on imported plant material. Among these, one case of powdery scab was found on potatoes from Ecuador, confirming the supposed Andean origin of this disease, and one interception of citrus canker was made at Seattle, Wash., on citrus fruits taken from passengers' baggage.

INSPECTION OF PLANT-INTRODUCTION GARDENS.

The board has continued its annual or more frequent inspection of the plant-introduction gardens maintained by the Department of Agriculture at Yarrow, Md.; Miami and Brooksville, Fla.; Savannah, Ga.; and Chico, Calif., and the field station of the Office of Dry-Land Agriculture at Mandan, N. Dak.

TERMINAL INSPECTION OF INTERSTATE MAIL SHIPMENTS OF PLANTS AND PLANT PRODUCTS.

During the year the State of Arkansas, under authority of the act of March 4, 1915, made provision for terminal inspection of mail shipments of plants and plant products originating in other States. California, the first State to make provision for such inspection, in 1915, was followed in 1916 by Arizona and Montana; in 1917 by Florida, and in 1918 by Washington.

NEW PLANT QUARANTINES.

The following foreign and domestic quarantines and other restrictive orders have been promulgated or revised during the year:

DOMESTIC.—The Japanese beetle quarantine, the European corn borer quarantine, the black stem rust quarantine, and the gipsy moth and brown-tail moth quarantine (a revision).

FOREIGN.—The bamboo quarantine and the nursery stock, plant, and seed quarantine.

The most important of these quarantines have been made the subject of specific discussion and explanation elsewhere in this report. The gipsy moth and brown-tail moth quarantine represents merely

the annual revision of this quarantine to take account of necessary changes in the distribution of these insects. The extensive clean-up operations along the western border of infestation, combined with the destruction of the egg masses by the severe cold of the winter of 1917-18, made it possible to materially decrease the area quarantined on account of the gipsy moth. As was the case during the last two years, it was again not necessary to extend the areas quarantined on account of the brown-tail moth.

COTTON WASTE AND UNMANUFACTURED COTTON USED AS PACKING FOR IMPORTED ARTICLES.

It was discovered by the inspectors of the board that considerable quantities of cotton and cotton waste containing seeds was being brought into this country in the form of packing for china, bric-a-brac, and other similar articles from Japan and China. An importation of chocolate from Mexico by parcel post packed in seed cotton was also intercepted. To guard against the possible entry of the pink bollworm with importations of this kind, at the request of this department, the Treasury Department instructed all customs officers to hold all importations packed with cotton or cotton waste and to report the facts to the local inspector of the Federal Horticultural Board at the port where the merchandise is offered for entry, or, in the absence of a local inspector at said port, either to report the shipment to the Department of Agriculture or require the importer to remove and burn all such packing under the supervision of a customs officer before entry of the merchandise is completed.

SHIP'S BALLAST AS A SOURCE OF INTRODUCING PLANT ENEMIES.

The attention of the board has been repeatedly drawn to the supposed risk of entry of plant pests in ships' ballast. This was especially urged by persons who objected to Quarantine No. 37, and who made the argument that there was a risk from such ballast equal to that of plants with soil. Through the agency of inspectors at the principal ports of entry into the United States, the board has had a careful investigation made of such ballast. It was evident that war conditions had very much increased the amount of ballast thus brought to the principal eastern ports on account of the necessity prior to the armistice of vessels employed in the transportation of troops and supplies returning for the most part in ballast. It was found, however, that material employed for such ballast would seem to involve very little risk of being the means of introduction of dangerous plant enemies. The bulk of it was found to consist of sand, gravel, broken rock, and even ashes. The soil occasionally employed seems to have been derived from river banks or from excavations for construction purposes (cellar soil). It was not shown, and it is not at all probable, that valuable garden or field soil is ever used for such ballast purposes. The sand and gravel is as a rule sold for building or other construction purposes, and the broken rock and soil have been used to some extent for filling in, and that brought in on Government vessels very largely for fills in connection with Government constructions on the water front. Some of this ballast has been towed to sea and dumped along with city waste. While there may be a possibility of plant pests being brought in with such soil, it is a very remote one, and undoubtedly such use of ballast will be very largely reduced when normal commercial conditions are resumed.

WAR ACTIVITIES.

The restrictions on foreign commerce necessitated by the war brought the Federal Horticultural Board into some cooperative relationship with the War Trade Board, particularly in regard to the importation of foreign cotton. This had to do with the determination of the amount of foreign cottons which should be permitted to enter the United States to meet essential war and other needs and to the enforcement of the regulations of this department in so far as they covered products permitted entry by the War Trade Board.

NEED FOR ENLARGEMENT OF PORT INSPECTION SERVICE.

One of the most important and useful features of the work under the board is its port inspection service. This service was started to meet the need for necessary control of the entry and disinfection of imported cotton on account of the pink bollworm. The work necessitates the maintaining of inspectors at the ports of Boston, New York, San Francisco, Seattle, and Calexico, the only ports at which foreign cottons are permitted entry into the United States. The board is also maintaining an inspection and quarantine service along the Mexican border to prevent the accidental entry of cotton and cotton seed with the railway, freight, and other traffic entering the United States from Mexico. The work of this service during the year is referred to elsewhere in this report.

In addition to the port inspection service in relation to foreign cotton, and on the Mexican border, this department is now enforcing fifteen quarantines prohibiting or restricting the entry of foreign plants and plant products. It is also enforcing seven orders regulating and restricting the entry of such products. These quarantines and orders are being enforced in part through cooperation with the customs service. The burden on the customs service, however, has grown to such an extent that it has been necessary to take over the actual enforcement of these quarantines at the principal ports of entry, as far as is possible, through the existing port inspection service referred to above. Furthermore, the officers of the customs service lack the technical information necessary for the proper enforcement of the plant quarantines.

Only two States, California and Florida, have established adequate port inspection service for the protection of their citizens and incidentally of the country as a whole. This department has been able to collaborate with the port inspection service of these two States in the enforcement of the Federal quarantines and restrictive orders referred to. The value of this State service to the States of California and Florida has been fully demonstrated, and these States are now maintaining a service of a score or more of men each, covering all the ports of entry into these States, at an annual cost of many thousands of dollars.

The need of such port inspection service has been abundantly shown by the results obtained through the protection afforded in these States and by work which has been undertaken in a limited way by the Federal Government. Such an inspection service was tentatively installed at New Orleans for six weeks, and the amount of infested plant and food material intercepted by the inspection of shipping which entered that port, including both ships' cargoes and ships' stores and miscellaneous fruits and plants carried by passengers and crews, fully demonstrated the danger which is constantly being

run at all ports of entry and especially the Pacific, Gulf, and south Atlantic ports.

It frequently happens that shiploads of products which are prohibited entry into the United States enter these ports either for transshipment of such cargoes into other vessels en route to foreign countries or for temporary purposes, such as coaling or provisioning or other immediate needs, and that such ships lie at anchor in such ports for days or weeks together. There have been repeated instances of shiploads of cotton seeds from Brazil, and even from South Africa, thus remaining at such ports as New Orleans and Norfolk—seeds which were more or less heavily infested with pink bollworm or other dangerous insects. Such cargoes involve great danger of escape of insects to adjoining fields cropped to host plants of such insects. Such shipping should be safeguarded by inspection, and the cargoes, where necessary, should be sealed or disinfected. It has become apparent, therefore, that the port inspection service of this department should be greatly strengthened.

To establish such comprehensive and thoroughgoing port inspection service as is urgently needed to prevent new plant enemies from being brought into the United States, and for a more effective administration of existing quarantines, an increase of \$100,000 in the general appropriation has been asked for in the estimates submitted for the fiscal year ending June 30, 1921.

A PLANT-QUARANTINE LAW NEEDED FOR THE DISTRICT OF COLUMBIA.

There is at present no law under which the movement of diseased or insect-infested nursery stock and other plants and plant products into the District of Columbia from surrounding or other States, or from the District of Columbia into surrounding or other States, can be adequately controlled, nor is there statutory authority for control and extermination within the District of Columbia of plant pests and diseases. Such control is exercised under State and Territorial laws elsewhere in the United States. Under present conditions, therefore, the District of Columbia is without such protection, and becomes in fact a menace to the surrounding country as a means of lodgment and dissemination of dangerous plant pests. Illustrating this condition, one of the worst pests which has recently been introduced into the United States, the oriental fruit moth, which now seriously threatens the deciduous-fruit industry of this country, gained entrance in large part through importations of ornamental stock into the District of Columbia; and there exist now within the District of Columbia thousands of peach, plum, cherry, apple, and other trees infested with this insect, affording breeding sources from which the insect has already spread to the adjacent States of Maryland and Virginia.

To meet this need a draft of a proposed amendment to the plant-quarantine act of August 20, 1912, was prepared by this board in co-operation with the office of the solicitor of this department and was submitted to Congress by the Secretary of Agriculture for incorporation with the appropriations for the Federal Horticultural Board for the fiscal year ending June 30, 1920. This amendment was approved by the House and Senate Committees on Agriculture, but failed of enactment. The powers requested are proper and necessary, and it is hoped that early favorable action on this proposed amendment can be secured.

LIST OF CURRENT QUARANTINE AND OTHER RESTRICTIVE ORDERS.

QUARANTINE ORDERS.

The numbers assigned to these quarantines indicate merely the chronological order of issuance of both domestic and foreign quarantines in one numerical series. The quarantine numbers missing in this list are quarantines which have been either superseded or revoked. For convenience of reference these quarantines are here classified as domestic and foreign.

DOMESTIC QUARANTINES.

Date palms.—Quarantine No. 6: Regulates the interstate movement of date palms or date-palm offshoots from Riverside County, Calif., east of the San Bernardino meridian; Imperial County, Calif.; Yuma, Maricopa, and Pinal Counties, Ariz.; and Webb County, Tex.; on account of the Parlatoria scale (*Parlatoria blanchardi*) and the Phoenicococcus scale (*Phoenicococcus marlatti*).

Cotton seed and cottonseed hulls.—Quarantine No. 9: Prohibits the importation of cotton seed and cottonseed hulls from the Territory of Hawaii on account of the pink bollworm.

Hawaiian fruits.—Quarantine No. 13, revised: Prohibits or regulates the importation from Hawaii of all fruits and vegetables, in the natural or raw state, on account of the Mediterranean fruit fly and the melon fly.

Sugar cane.—Quarantine No. 16: Prohibits the importation from Hawaii and Porto Rico of living canes of sugar cane, or cuttings or parts thereof, on account of certain injurious insects and fungous diseases.

Cotton.—Quarantine No. 23, revised: Regulates the movement of cotton from Hawaii to the continental United States, on account of the pink bollworm.

Five-leaved pines, Ribes and Grossularia.—Quarantine No. 26, as amended: Prohibits the interstate movement of five-leaved pines, currant and gooseberry plants from all States east of and including the States of Minnesota, Iowa, Missouri, Arkansas, and Louisiana to points outside of this area; prohibits, further, (1) the interstate movement of five-leaved pines and black-currant plants to points outside the area comprising the States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and New York, and (2) to protect the State of New York, the movement from the New England States, on account of the white-pine blister rust.

Sweet potato and yam.—Quarantine No. 30: Prohibits the movement from the Territories of Hawaii and Porto Rico into or through any other Territory, State, or District of the United States of all varieties of sweet potatoes and yams (*Ipomoea batatas* and *Dioscorea* spp.), regardless of the use for which the same are intended, on account of the sweet-potato weevil (*Cylas formicarius*) and the sweet-potato scarabee (*Euscepes batatae*).

Banana plants.—Quarantine No. 32: Prohibits the movement from the Territories of Hawaii and Porto Rico into or through any other Territory, State, or District of the United States of any species or variety of banana plants (*Musa* spp.), regardless of the use for which the same are intended, on account of two injurious weevils, *Rhabdoenemis obscurus* and *Metamasius hemipterus*.

Gipsy moth and brown-tail moth.—Quarantine No. 33, revised: Regulates the movement interstate to any point outside of the quarantined towns and territory, or from points in the generally infested area to points in the lightly infested area, of stone or quarry products, and of the plants and the plant products listed therein. The quarantine covers portions of the States of Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut.

Japanese beetle.—Quarantine No. 35: Regulates the movement interstate to any point outside the townships of Delran, Chester, and Cinnaminson, Burlington County, N. J., of green corn, commonly called sweet or sugar corn, on account of the Japanese beetle (*Popillia japonica*).

European corn borer.—Quarantine No. 36: Prohibits the movement interstate to any point outside of the quarantined area of corn fodder or cornstalks whether used for packing or otherwise, green sweet corn, roasting ears, corn on the cob, and corncobs, on account of the European corn borer (*Pyrausta nubilalis*).

Black stem rust.—Quarantine No. 38: Prohibits the movement interstate to any point outside of the quarantined area of the common barberry and its horticultural varieties, as well as certain other species of *Berberis* and *Mahonia*, on account of the black stem rust of wheat, oats, barley, rye, and many wild and cultivated grasses.

FOREIGN QUARANTINES.

Irish potato.—Quarantine No. 3: Prohibits the importation of the common or Irish potato from Newfoundland; the islands of St. Pierre and Miquelon; Great Britain, including England, Scotland, Wales, and Ireland; Germany; and Austria-Hungary, on account of the disease known as potato wart.

Mexican fruits.—Quarantine No. 5, as amended: Prohibits the importation of oranges, sweet limes, grapefruit, mangoes, achras sapotes, peaches, guavas, and plums from the Republic of Mexico, on account of the Mexican fruit fly.

Five-leaved pines, Ribes, and Grossularia.—Quarantine No. 7, as amended: Prohibits the importation from each and every country of Europe and Asia, and from the Dominion of Canada and Newfoundland, of all five-leaved pines and all species and varieties of the genera *Ribes* and *Grossularia*, on account of the white-pine blister rust.

Cotton seed and cottonseed hulls.—Quarantine No. 8, as amended: Prohibits the importation from any foreign locality and country, excepting only the locality of the Imperial Valley, in the State of Lower California, Mexico, of cotton seed (including seed cotton) of all species and varieties, and cottonseed hulls, on account of the pink bollworm. Cotton and cotton seed from the Imperial Valley may be entered under permit and regulation.

Seeds of avocado or alligator pear.—Quarantine No. 12: Prohibits the importation from Mexico and the countries of Central America of the seeds of the avocado or alligator pear, on account of the avocado weevil.

Sugar cane.—Quarantine No. 15: Prohibits the importation from all foreign countries of living canes of sugar cane, or cuttings or parts thereof, on account of certain injurious insects and fungous diseases. There are no restrictions on the entry of such materials into Hawaii and Porto Rico.

Citrus nursery stock.—Quarantine No. 19: Prohibits the importation from all foreign localities and countries of all citrus nursery stock, including buds, scions, and seeds, on account of the citrus canker and other dangerous citrus diseases. The term "citrus," as used in this quarantine, includes all plants belonging to the subfamily or tribe *Citrata*.

European pines.—Quarantine No. 20: Prohibits, on account of the European pine-shoot moth (*Evtria buoliana*), the importation from all European countries and localities of all pines not already excluded by Quarantine No. 7.

Indian corn or maize and related plants.—Quarantine No. 24, as amended: Prohibits the importation from southeastern Asia (including India, Siam, Indo-China, and China), Malayan Archipelago, Australia, New Zealand, Oceania, Philippine Islands, Formosa, Japan, and adjacent islands, in the raw or unmanufactured state, of seed and all other portions of Indian corn or maize (*Zea mays* L.), and the closely related plants, including all species of *Teosinte* (*Euchlaena*), *Job's tears* (*Coix*), *Polytoca*, *Chionachne*, and *Sclerachne*, on account of the downy mildews and *Phyodermis* diseases of Indian corn, except that Indian corn or maize may be imported on compliance with the conditions prescribed in the regulations of the Secretary of Agriculture.

Citrus fruit.—Quarantine No. 28: Prohibits the importation from eastern and southeastern Asia (including India, Siam, Indo-China, and China), the Malayan Archipelago, the Philippine Islands, Oceania (except Australia, Tasmania, and New Zealand), Japan (including Formosa and other islands adjacent to Japan), and the Union of South Africa of all species and varieties of citrus fruits, on account of citrus canker, except that oranges of the mandarin class (including satsuma and tangerine varieties) may be imported on compliance with the conditions prescribed in the regulations of the Secretary of Agriculture.

Sweet potato and yam.—Quarantine No. 29: Prohibits the importation for any purpose of any variety of sweet potatoes or yams (*Ipomoea batatas* and

Dioscorea spp.) from all foreign countries and localities, on account of the sweet potato weevils (*Cylas* spp.) and the sweet potato scarabee (*Eusepeus batatae*).

Banana plants.—Quarantine No. 31: Prohibits the importation for any purpose of any species or variety of banana plants (*Musa* spp.), or portions thereof, from all foreign countries and localities, on account of the banana root borer (*Cosmopolites sordidus*).

Bamboo.—Quarantine No. 34: Prohibits the importation for any purpose of any variety of bamboo seed, plants, or cuttings thereof capable of propagation, including all genera and species of the tribe *Bambuseae*, from all foreign countries and localities, on account of dangerous plant diseases, including the bamboo smut (*Ustilago shiraiana*). This quarantine order does not apply to bamboo timber consisting of the mature dried culms or canes which are imported for fishing rods, furniture making, or other purposes, or to any kind of article manufactured from bamboo, or to bamboo shoots cooked or otherwise preserved.

Nursery stock, plants, and seeds.—Quarantine No. 37, as amended, with regulations (effective on and after June 1, 1919): Prohibits the importation of nursery stock and other plants and seeds from all foreign countries and localities on account of certain injurious insects and fungous diseases, except as provided in the regulations. Under this quarantine the following plants and plant products may be imported without restriction: Fruits, vegetables, cereals, and other plant products imported for medicinal, food, or manufacturing purposes, and field, vegetable, and flower seeds. The entry of the following plants is permitted under permit: Lily bulbs, lily of the valley, narcissus, hyacinths, tulips, and crocus; stocks, cuttings, scions, and buds of fruits; rose stocks, including manetti, multiflora, brier rose, and rosa rugosa; nuts, including palm seeds; seeds of fruit, forest, ornamental, and shade trees; seeds of deciduous and evergreen ornamental shrubs, and seeds of hardy perennial plants.

Provision is also made for the issuance of special permits under safeguards to be prescribed in such permits for the entry in limited quantities of nursery stock and other plants and seeds not covered in the preceding lists for the purpose of keeping the country supplied with new varieties and necessary propagating stock.

Flag smut and take-all.—Quarantine No. 39, with regulations (effective on and after August 15, 1919): Prohibits the importation of seed or paddy rice from Australia, India, Japan, Italy, France, Germany, Belgium, Great Britain, Ireland, and Brazil on account of two dangerous plant diseases known as flag smut (*Urocystis tritici*) and take-all (*Ophiobolus graminis*). Wheat, oats, barley, and rye may be imported from the countries named only on compliance with the conditions prescribed in the regulations of the Secretary of Agriculture.

OTHER RESTRICTIVE ORDERS.

The regulation of the entry of nursery stock from foreign countries into the United States was specifically provided for in the plant-quarantine act. The act further provides for the similar regulation of any other class of plants or plant products when the need therefor shall be determined. The entry of the plants and plant products listed below has been brought under such regulation:

Nursery stock.—The conditions governing the entry of nursery stock and other plants and seeds from all foreign countries and localities are indicated above under "Foreign quarantines." (See Quarantine No. 37.)

Irish potatoes.—The importation of Irish potatoes is prohibited altogether from the countries enumerated in the potato quarantine. Potatoes may be admitted from other foreign countries in accordance with the order of December 22, 1913, bringing the entry of potatoes under restriction on account of injurious potato diseases and insect pests. The following countries have qualified for the importation of potatoes under the regulations issued under said order: Denmark, Holland, Belgium, Cuba, Bermuda, and the Dominion of Canada. The regulations issued under this order have been amended so as to permit, free of any restrictions whatsoever under the plant-quarantine act, the importation of potatoes from any foreign country into the Territories of Porto Rico and Hawaii for local use only and from the Dominion of Canada and Bermuda into the United States or any of its Territories or Districts.

Avocado, or alligator pear.—The order of February 27, 1914, prohibits the importation from Mexico and the countries of Central America of the fruits of the avocado, or alligator pear, except under permit and in accordance with the

other provisions of the regulations issued under said order, on account of the avocado weevil. Entry is permitted only through the port of New York, and is limited to the large, thick-skinned variety of the avocado. The importation of the small, purple, thin-skinned variety of the fruit of the avocado and of avocado nursery stock under 18 months of age, is prohibited.

Cotton.—The order of April 27, 1915, prohibits the importation of cotton from all foreign countries and localities, except under permit and in accordance with the other provisions of the regulations issued under said order, on account of injurious insects, including the pink bollworm. These regulations apply in part to cotton grown in and imported from the Imperial Valley, in the State of Lower California, in Mexico.

Corn.—The order of March 1, 1917 (Amendment No. 1, with Regulations, to Notice of Quarantine No. 24), prohibits the importation of Indian corn or maize in the raw or unmanufactured state from the countries and localities listed in Notice of Quarantine No. 24, except under permit and in accordance with the other provisions of the regulations issued under said order, on account of injurious diseases of Indian corn.

Cottonseed products.—The order of June 23, 1917, prohibits the importation of cottonseed cake, meal, and all other cottonseed products, except oil, from all foreign countries, and a second order of June 23, 1917, prohibits the importation of cottonseed oil from Mexico except under permit and in accordance with the other provisions of the regulations issued under said orders, on account of injurious insects, including the pink bollworm.

Citrus fruits.—The order of June 27, 1917 (Notice of Quarantine No. 28, with Regulations), prohibits the importation from the countries and localities listed therein of all species and varieties of citrus fruits, excepting only oranges of the mandarin class (including satsuma and tangerine varieties), on account of the citrus-canker disease. Oranges of the mandarin class (including satsuma and tangerine varieties) may be imported under permit and in accordance with the other provisions of the regulations issued under said order.

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